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THE IMPROVEMENT OF THE CHICAGO RIVER in relation to its navigation and to its connection with the Drainage Canal was discussed by Mr. L. E. Cooley, M. Am. Soc. C. E., in an address delivered at the annual meeting of the Western Society of Engineers, Jan. 8. His suggestion for a special commission of five experts has been approved by the Citizens' Committee which has taken up the matter of river improvement. This committee has also advocated the removal of the Washington St. bridge, as being the most serious obstruction to navigation. The Sanitary Board has adopted the recommendation for such a commission, and has appointed the following as members: Orrin N. Carter (Judge of the County Court); John P. Wilson (Attorney); A. V. Powell, Lyman E. Cooley, M.Am. Soc. C. E.; A. V. Powell, M. W. Soc. C. E.; and L. P. Friestedt (engineers). Associated with this commission in a consulting capacity will be the following: Major J. H. Willard, U. S. Engineers; L. E. McGann, Commissioner of Public Works; Charles M. Walker, Corporation Counsel; Isham Randolph, Chief Engineer of the Sanitary District; John S. Runnells, General Counsel for Sanitary District, and Zina B. Carter, Chairman of the Finance Committee of the Drainage Board. Other associafes will comprise representatives of the state and city health departments, the Board of Trade, Real Estate Board, and River Improvement Association. The commission is to consider the removal of center pier bridges, the widening of the channel to give increased flow, the establishment of dock lines, and the lowering of the tunnels. It is to make its report by March 1. Some extracts from Mr. Cooley's address are given below:

The United States has said that we could use the Chicago River provided we did not exceed a current of 1¼ miles an hour, and that this use was not to be to the detriment of commerce. That it has been detrimental is universally conceded, and to continue to use the river as it has been used during the last year is simply to invite a revocation of the permit by the Secretary of War, without any legal or equitable right of protest. On the other hand, not to furnish the volume of water required by the state law is liable to invoke the redress which the law provides.

Furthermore, in case the government shall undertake the improvement of the Desplaines and Illinois Rivers, to secure not less than 14 ft. of water between Chicago and St. Louis, then the Sanitary District will be required to complete the channel with a capacity of not less than 600,000 cu. ft. a minute within one year.

The third proposition is that Chicago has already suffered greatly in its commercial development on account of an inadequate river. When Chicago has ceased to make efforts to remedy this question, then the Secretary of War will reduce the flow of water in the interest of navigation, and the Illinois Valley will insist on its rights to have a full flow of water under the law; so that inaction in this matter places Chicago between the devil and the deep sea.

It is proposed the Sanitary District shall constitute a special committee of three engineers and two lawyers, who are familiar with the questions to be solved, so that they may rapidly crystalize a general project and line of action. It is proposed to associate with this committee in a consulting capacity official representatives of the United States, of the city, of the state and of the Sanitary District, so that all these agencies may at once acquiesce in some plan of co-operation.

THE CHICAGO BRIDGES AND VIADUCTS and their dilapidated condition have been referred to recently in our columns, and the latest news is to the effect that four bridges (W. Division St., 22d St., Archer Ave. and North Ave.), have been pronounced unsafe; while five others (Wells St., Harrison St., 18th St., Washington St. and 12th St.), are so in need of protection and repair that the city engineer refuses to be responsible for them. No money is available for repairs or reconstruction. Contracts had been made for the protection works, and were signed by the Commissioner of Public Works, but not by the Controller, who claims that there is now no money available and that therefore the contracts cannot legally be awarded.

A CHICAGO CITY AND HARBOR SCHEME has been proposed by Mr. A. J. Scherzer, of the Scherzer Rolling-Lift Bridge Co., Chicago. His idea is to make an entirely new section of the city by filling in on the lake front for a width of about four miles, or to a depth of 35 ft. of water. With a frontage of nearly 21 miles on the lake; this would give some 80 sq. miles of additional territory, to be laid out on the most modern principles of municipal design, and the Chicago River would be carried through it by a broad channel. An internal harbor for the largest vessels would be established by the improvement of existing rivers, and ship canals would be built through the Calumet district to the river and the Drainage Canal, and through the upper part of the city to the north branch of the Chicago River.

STATE AID FOR THE IMPROVEMENT of the Delaware River is asked for by Philadelphia commercial interests. The national government is now engaged in deepening the channels of the Delaware and Schuylkill Rivers, a 30-ft. depth being proposed. But the complaint is made that progress is too slow under government appropriations; and if those interested await government completion they are likely to lose the commerce of Philadelphia, as the economical transport of ocean freight now demands very large and deep vessels. It is argued that the State is thus directly interested and should aid in improvement.

A CANAL IMPROVEMENT BILL is before the German Diet, calling for expenditures as follows: Midland Canal, $65,000,000; Berlin-Stettin Canal, $10,250,000; improvement of the Warthe and connection with the Vistula, $5,750,000; the Oder tidewater canal, $10,250,000; Havel-Spree Canal, $4,750,000. This is a total of $96,000,000, for which the Finance Minister is to sell bonds.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Monongahela Division of the Baltimore & Ohio R. R., at Anderson, W. Va., on Jan. 8. A locomotive running light collided head on with a freight train on a high trestle, wrecking the latter and killing seven men. The accident is attributed to a misunderstanding of orders.

CONTRACTS FOR 37,000 FT. OF WATER PIPE AT Pittsburg, Pa., have been awarded in connection with the new supply of purified water. The main, it is said, will range from about 48 to 36 ins. in diameter. The major portion will be of steel, and the contract for this section has been awarded to the T. A. Gillespie Co., for $469,500. The balance will be of cast-iron and will be furnished and laid by Booth & Flinn for $195,000. Both contractors are of Pittsburg. Mr. A. B. Shepperd is superintendent of water-works.

WATER PURIFICATION EXPERIMENTS AT ST. Louis, Mo., are provided for in an ordinance adopted by the board of public improvements and introduced in the house of delegates of the city a few days ago. An appropriation of $25,000 would be used to install a 1,000,000-gallon mechanical and a 500,000-gallon slow sand filtration plant.

GARBAGE COLLECTION AND DISPOSAL AT PHILADelphia is in an unfortunate condition. On Dec. 6, 1900, the American Contracting & Manufacturing Co. was notified that its bid for garbage collection and disposal for the year 1901 had been accepted, subject to certain conditions, among which was one to the effect that the plant must be "completed and in thorough working order by Jan. 1, 1901." The company began to collect garbage on Jan. 1 and to remove it to a plant somewhere down the river, for reduction. On Jan. 7, the contractor notified the director of public works that it had suspended operations on account of alleged persecution from the police during the past week, culminating in the arrest of 19 employees on Jan. 5. The director of public safety claims that the garbage was not properly collected and that the employees in question were arrested for dumping 1,000 loads of garbage on lots and meadows and covering it with earth, "contrary to the ordinance of councils and the terms of the contract." This the contractor denies and, in short, it is claimed by the contractor and the opponents of the city administration, that the city officials, with the exception of the department of public works, have been determined to compel the abandonment of the contract, in order that it may be awarded to the next highest bidder, the American Product Co., which has done the work for a number of years past, but which bid $448,000 this year against the $333,800, at which the contract was provisionally awarded. The contract had not been executed, nor had the contractor made the guarantee deposit called for in the contract. In addition to what has been noted, the American Product Co. has increased the complications by bringing an infringement suit against its rival. On Jan. 8, the director of public works awarded the contract to the American Product Co., conditioned on the necessary appropriation by the city council, and the old contractor resumed operations.

THE OIL WELL lately struck on Jan. 10 in Southeastern Texas, 18 miles from Sabine Pass, seems to open up a new oil territory. The press reports speak of a flow of 15,000 barrels per day from a 6-in. casing. The oil was found at a depth of less than 1,000 ft., and of the same specific gravity—37°—as the oil of the Corsicana field, 240 miles northwest. As no tankage was provided the oil is running into the Sabine River.

MAXIMITE, a high explosive invented by Mr. Hudson Maxim, was tested at Sandy Hook last week. According to accounts, a 1,000 lb. 12-in. shell was filled with 70 lbs. of Maximite and fired through a 7-in. plate without explosion, thus making it equal to wet compressed guncotton in this respect. By exploding the Maximite a 12-in. shell was broken into about 10,000 fragments, as at least 7,000 pieces were recovered.

THE NEW POWER TRANSMISSION LINE that is being built by the Niagara Falls Power Co. between its powerhouse at Niagara Falls and its Niagara St. terminal station in Buffalo is approaching completion and will be in operation within a short time. This is the second transmission line built by the Niagara Falls Power Co. between these two points. When the new line is finished both lines will be worked at 22,000 volts. The voltage on the present line is 11,000, but when the installation in connection with it was put in, the transformers and other apparatus were designed for either voltage, so that few changes in apparatus will be necessary to effect the change. The old transmission line consists of six copper cables, or two three-phase systems, each cable having 19 strands. The new cables are of aluminum, having 300,000 circular mils cross section and 37 strands to each cable. The route selected for the new transmission line follows the old right of way to the south boundary line of the village of Tonawanda. At the point where the old transmission line crosses the tracks of the New York Central R. R., the new aluminum line diverges and runs over a new right of way, which is 30 ft. wide. The new route to the terminal station, from the point where the lines separate, is 3.18 miles shorter than the old route, and this effects quite a saving in construction. While the construction of the new line has been going on, the Niagara Falls Power Co. has given some attention to straightening out the crooks in the old line, especially through the North Tonawanda section of the line, where it was extremely crooked. This has been done owing to the decision that with a straight line there is less liability to interruption of the service. In its general construction the new line is very similar to the old line. The poles used average about 35 ft. in length, which gives 22 ft. clear of the ground. As the aluminum cable is much lighter than the copper cables, this has permitted the placing of the poles of the new line 112½ ft. apart on the average, while the poles of the old line are about 75 ft. apart. The insulators on the old line are white, while those on the new line are reddish brown and were made by C. S. Knowles, of Boston, Mass. The shank of the pin on which the new insulators set is heavier than the pins of the old insulators. The aluminum cable was made by the Pittsburg Reduction Co. When this new line is in operation Buffalo will be connected with the generating station at Niagara Falls by transmission lines that can supply 30,000 electrical HP.

AN ELEVATOR ACCIDENT resulting in the deaths of two people, occurred in a department store at Paterson, N. J., on Dec. 22. Through the confusion or incompetence of the elevator boy the car, loaded with eight people, was allowed to descend at full speed from the second floor to the basement. The counterbalance weights were jerked loose at the top of the 68-ft. shaft and fell, plunging through the roof of the car. The coroner's jury empanelled to inquire into the cause of the death of one of the victims reported that they found by the evidence of witnesses and expert testimony that the elevator boy made no effort to stop the car, and that he had not been properly instructed and was incompetent. The jury was unable to determine the immediate cause of the accident, but recommended a change and safe construction of the weights and guides. They also recommended that only competent and properly instructed persons be allowed to run elevators.

LOWER FREIGHT RATES ON IRON go into effect on Feb. 1. All iron and steel products, to which the 5th class rate applies, will be carried on a basis of 25 cts. per 100 lbs. from Chicago to New York. The Buffalo-New York rate will be applied from Pittsburg to New York, reducing the eastbound rate 5 cts. per 100 lbs. The pig iron and steel billet rates will be reduced 50 cts. per ton from Pittsburg to New York and Pittsburg to Chicago.

CONVERTING A FIXED BRIDGE SPAN INTO A SWING SPAN.

An interesting piece of work recently carried out on the Pere Marquette R. R., was the conversion of a fixed plate-girder span over the Kalamazoo River, at New Richmond, Mich., into a swing span. When the railway was built, a "jack-knife" draw was built over this river, consisting of a pony Howe truss under each rail, about 70 ft. long, giving 60 ft. clear opening. Small steamers were then running from Saugatuck, at the mouth of the Kalamazoo River, to Allegan, about 15 miles above New Richmond. These were taken off about 15 years ago, and as the trusses in the draw became old the span was first shortened,

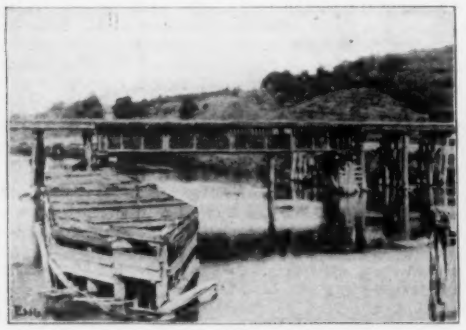


Fig. 1.—Fixed Span.

Fig. 2.—Swing Span, Closed.

Fig. 3.—Swing Span, Open.

PLATE GIRDER BRIDGE CONVERTED FROM A FIXED SPAN TO A SWING SPAN; PERE MARQUETTE R. R.

then they were spread and ties put on them making a fixed span, and in 1897 they were replaced by a deck plate-girder bridge 70 ft. long. Soon afterwards, a movement was started in Saugatuck to require the railway company to replace the draw, which finally resulted in an order from the U. S. Government for an opening 40 ft. wide.

As it was not probable that the draw would be often used, the cheapest and simplest means of complying with the order was sought, and a design submitted by Mr. J. W. Schaub, M. Am. Soc. C. E., Consulting Engineer, Monadnock Block, Chicago, for changing the 70-ft. deck girder to a counterbalanced swing span of unequal ends, was accepted by Mr. J. J. McVean, M. Am. Soc. C. E., then Chief Engineer of the railway, as best accomplishing this. It was also decided to use the piles of the old pier for the new pivot pier, which necessitated moving the girder endways 20 ft. to the south. The piles were driven for the new end supports, the girder moved, pivot pier built, the turntable put in place and the concrete filling for counterweight placed in the south end, without interfering with trains. When balanced over the pivot pier, the long arm was found to have a deflection of 1¾ ins.; this was taken care of by raising the turntable ½-in. and rebalancing the two arms. The turntable was made by the Detroit Bridge & Iron Works, from Mr. Schaub's plans. The same firm also built the girders. The timber and concrete work were done by the railway company's men. Fig. 1 is a view of the plate-girder fixed span, with the old pivot pier at the left. Fig. 2 shows the swing span closed, and Fig. 3 shows the span open. The total weight of the bridge, carried upon the turntable center, is 80 tons.

No change was made in the bridge itself, except to place additional stiffeners over the turntable, and to put in a flooring to hold the concrete counterweight. The center of rotation is 20 ft. from the short end of the span. The turntable consists of a rectangular girder which is supported by a center pin 8¼ ins. diameter. This pin carries the dead load only, the live load being transmitted directly to the pier by means of supports under the main girders. The gearing is composed of a circular rack and pinion with two motions, operated by capstan bars fitted to socket heads between the rails. The time of opening and closing the bridge with the slow motion is about 90 seconds. For an end latch the rail splices are used.

The work was done without interfering with traffic, the bridge being moved forward by sliding it on rails. The cost of the entire work was only about $2,000. The work was carried out by Mr. J. Tuthill, M. Am. Soc. C. E., Engineer of Bridges, Pere Marquette R. R., to whom we are indebted for the above information.

THE PRESIDENTS OF FOUR AMERICAN ENGINEERING SOCIETIES.

(With Inset Sheet of Portraits.)

In this issue, according to our annual custom, we present to our readers portraits of the recently elected presidents of four American engineering societies, with brief biographies of each. Mr. James Douglas, President of the American Institute of Mining Engineers, whose portrait and biography we gave a year ago, was re-elected at the last annual meeting. The fourth place on our page, therefore, is again given to the American Society of Municipal Improvements.

J. JAMES R. CROES.

Mr. J. James R. Croes, the newly-elected President of the American Society of Civil Engineers, was born in Richmond, Va.,Nov. 25, 1834. He was named for his two grandfathers, John Croes, the first Protestant Episcopal Bishop of New Jersey, and James Robertson, a banker of Philadelphia and Richmond. In 1843 his father, a clergyman of the Protestant Episcopal Church, removed from New Jersey to Terre Haute, Ind. The difficulties of overland transportation at that period were so great that Mr. Croes found the most convenient mode of conveying his family and household goods to the banks of the Wabash to be by taking a sailing packet from New York to New Orleans, then a Mississippi River steamboat to Evansville on the Ohio River and making the rest of the journey on a stern-wheel steamboat up the Wabash.

In 1850, when young Croes came East again to go to college, the first seventy miles of the journey had to be made in a mud-wagon, a heavy box wagon without springs and with a canvas cover, drawn by four horses over the National Road to Indianapolis, the western terminus of the then recently-constructed Richmond & Indianapolis R. R.

In 1853 Mr. Croes graduated at the College of St. James, near Hagerstown, Md. This institution is no longer in existence, but among its students in those days were a number of young men whose names have since become well known; among them Col. William E. Merrill, Corps of Engineers, U. S. A.; Rev. Dr. Eliphalet Nott Potter, President of Union College, and later of Hobart College; Capt. Alfred T. Mahan, U. S. N., and others.

After graduation Mr. Croes took up the study and practice of civil engineering in New Brunswick, N. J. He was for a while in the service of the New Jersey R. R. & Transportation Co., but in 1857 he went to Brooklyn to assist in the construction of the Ridgewood reservoir and engine house under Mr. James P. Kirkwood. On the completion of the Brooklyn water-works in 1860, he was engaged on the Croton water-works extension under Gen. George S. Greene, on the new reservoir in Central Park and the High Bridge enlargement, becoming the resident engineer on the latter work when Gen. Greene went to the war. This work included the construction of the first large wrought-iron pipe in the country. It is 90 ins. in diameter and 1,450 ft. long, and is still in use, carrying the water of the old Croton Aqueduct across the Harlem River.

In August, 1863, Mr. Croes was called to Washington, D. C., as principal assistant engineer on the Washington Aqueduct, which had been transferred from the War Department to the Department of the Interior. Here he had charge of the completion of the Aqueduct and the Cabin John Bridge, the building of the dam at Great Falls and the introduction of water to the city from Potomac River.

In 1865 he spent several months in Cincinnati assisting Mr. J. P. Kirkwood in investigation of the water supply, and then went to St. Louis, where he was engaged on the harbor improvements; but in December he was recalled to New York to take charge of the examinations for storage reservoirs in the Croton Valley. This resulted in the construction of the Boyd's Corners Dam, the first high masonry dam built in the United States. The design of the dam as prepared by Gen. Geo. S. Greene was novel. It consisted of two walls of dressed masonry with a hearting of concrete, in which large unwrought stone were imbedded to the extent of about one-third of the mass. The difficulties encountered in securing good workmanship in this work by inexperienced contractors are well described by Mr. Croes in a paper presented to the American Society of Civil Engineers, for which he was awarded the first Normal Medal in 1874.

Mr. John B. McDonald, the contractor for the underground Rapid Transit R. R. in New York city, had his first experience in the construction of Public Works created by the Tweed charter as contractor's clerk and assistant superintendent.

In October, 1870, the Croton Aqueduct Department having been transferred to the Department of Public Work created by the Tweed charter, Mr. Croes resigned his position and in company with Messrs. B. S. Church and E. B. Van Winkle engaged in general hydraulic and miscellaneous work. Among other investigations he examined and reported on an additional supply of water for Syracuse, N. Y., from the Tully Lakes.

From 1872 to 1878 Mr. Croes was in the service of the Department of Public Parks of New York city, first as principal assistant and later as chief engineer of the Topographical Bureau in charge of the surveys and the laying out of the street system of the newly annexed district north of the Harlem River, now called the Borough of the Bronx. This district covered an area of 20 square miles, of irregular outline, of extremely varied topography, the differences of elevation between large areas at nearly tide level and ridges and plateaus desirable for residential purposes being 225 ft.; traversed by three lines of trunk railways entering the city from the north; irregularly divided by old highways and cut up into detached villages laid out solely with the view of getting the greatest number of building lots on individual properties, and with old estates, abandoned farms and costly country seats scattered around indiscriminately. The problem presented to the Park Department was to devise a system of streets which should develop this territory in the most

advantageous manner for itself and the city of which it was made a part, with a view to economical construction, proper communication and drainage and with avoidance of too great interference with existing divisions of property.

In the original laying out of Manhattan Island, which has about the same area, the commissioners of 1807, who filed their map on All Fools Day, 1811, solved all such problems, as is well known, by laying a mason's sand screen on the map and making the streets and avenues conform to the wires of the screen. Sixty years of custom had made the rectangular division of property into multiples of 25 × 100 ft. lots appear to the real estate dealer the only possible method of laying out property. This was manifestly inapplicable to the new district, but some years was spent in efforts to come as near to it as possible.

Fragmentary efforts at the laying out of a few districts were made without much satisfaction until 1875, when Mr. Frederick Law Olmsted and Mr. Croes were directed to formulate a comprehensive scheme for the laying out of the district. Their joint report and the plans submitted therewith met with the approval of the commissioners and the public, and the work of carrying it out was begun by Mr. Croes and continued by his successor, Mr. E. B. Van Winkle, M. Am. Soc. C. E., Mr. Croes having resigned in 1878. Changes of administration and of policy delayed the completion of the laying out for twenty years, and were the occasion of many changes of detail, but the system as completed in 1896 is in general accord with the principles laid down by Messrs. Olmsted and Croes in 1876.

In 1877 they were directed by the department to also consider plans for rapid transit in the district. In their report they advocated the construction of railroads above the surface of the streets on their own purchased right of way. This view of the subject was adopted by several Rapid Transit Commissioners in 1880-83, of which Mr. Croes was the engineer. One of the companies organized was the West Side & Yonkers R. R., which built its line now owned by the N. Y. C. & H. R. R. R. Co. Another company created in May, 1880, the Suburban Rapid Transit Company, between 1883 and 1891 constructed and operated the railroad from 129th St. at Second Ave. across the Harlem River and up to Tremont, Mr. Croes being the chief engineer. This is a plate-girder elevated road, 3.5 miles long, about one-third of it being on its own right of way, where the girders are supported on brick piers. The structure and rolling stock were heavier than on the other elevated roads in and around New York. One result of this better construction was that in the memorable blizzard of March 12, 1888, this was the only steam road within fifty miles of New York on which there was no interruption of traffic by the snow. In 1891 this road was acquired by the Manhattan Co. and operated as part of its system.

In 1879 Mr. Croes made, in conjunction with Mr. George W. Howell, C. E., a very thorough investigation of the relative cost and value of various schemes for furnishing an additional supply of water to Newark, N. J. "The Croes and Howell Report," as it is called, is still referred to and quoted in all discussions on the water supply of Eastern New Jersey. In 1887-90 he made extensive examinations for the Lehigh Valley R. R. Co. with a view to furnishing water to Newark from sources which the company controlled, and aided in securing a contract under which the company supplied Newark with water for eleven years. On the expiration of the contract in 1900 he was retained by the city of Newark to examine the works and report upon their condition and value, with a view to the exercise of an option to purchase them. The works had been built by the East Jersey Water Co., which also supplied water to Jersey City under a temporary contract. In the discussion relating to a permanent supply, Mr. Croes was consulted by the Jersey City authorities a number of times.

In 1889 he made an exhaustive examination and report on the supply of water for Syracuse, N. Y., and aided in securing the consent of the Legislature and the Canal Board to the taking of water from Skaneateles Lake in accordance with his recommendations, in spite of strenuous opposition from those who feared that the supply of water from the Erie Canal would be thereby endangered. The Syracuse works were built after his plans and within his original estimates of their cost, by Mr. W. R. Hill, now chief engineer of the New York Aqueduct Commission.

In 1889, also, Mr. Croes, in conjunction with Messrs. J. P. Davis and W. F. Shunk, served on a commission to report on the plan and location of the Quaker Bridge dam of the Croton Aqueduct, and in the following year he made an examination of the repairs to defective work in the aqueduct by some of the contractors. His last work in connection with the New York water supply, was his report in April, 1900, to the Merchants' Association on the condition and needs of the present supply, in which he took the ground that the alleged deficiency of supply was due rather to maladministration than to lack of water, and recommended the general use of meters, both on main and service pipes. He had already, on Aug. 28, 1899, made a brief but comprehensive report to Controller Coler, condemning the Ramapo project on the ground that more water could be procured in less time and at less cost from the Ten-Mile River and that the main cause of the alleged deficiency of present supply was the enormous waste, much of which could be checked by the adoption of modern methods of administration. These contentions were fully sustained and corroborated by the elaborate investigations which Mr. John R. Freeman afterwards made for the Controller and reported to him on March 23, 1900.

For the last twenty years he has had an extensive practice as consulting engineer on hydraulic questions, and has made examinations and reports on water supply for a large number of cities and towns all over the country, and also for the sewerage of towns, the improvement of rivers, irrigation and water powers in the West, failures and defects in structures and the valuation of water-works and other plants. As an expert witness in cases of alleged damage to property by the taking or diversion of water his practice has been large.

In 1890 he made a four months' trip in Europe, taking a camera with him, and since then he has always carried a "Kodak" on his professional tours, thus keeping a record of events and places, which has frequently proved of great value, particularly before commissions and courts.

In 1895 he was appointed by Gov. L. P. Morton, of New York, one of the commissioners to procure the preservation of the Palisades of the Hudson by the acquisition by the National Government of the cliffs and a plateau on top as a National Park and Military Reservation for the mobilization and exercise of the army. The States of New York and New Jersey both enacted laws ceding the territory provisionally. Members of Congress, however, opposed the expenditure necessary, on the ground that there was no danger of war and no need of drilling the army, so that nothing could be accomplished. But when the war with Spain came suddenly, just such a ground was needed, and had to be hastily acquired in a distant, unhealthy and inaccessible spot.

While he has never written a book, Mr. Croes' contributions to engineering literature have been numerous. Besides papers and discussions published in the Transactions of the American Society of Civil Engineers and the American Water-Works Association, he contributed to Engineering News in 1881-2 historical and statistical descriptions of the water-works of over 800 cities. The principal statistics of these works and 600 others obtained from time to time he compiled in tabular form, and three editions were published by the Engineering News Publishing Co., the last in 1887, after which it was continued by Mr. M. N. Baker as "The Manual of American Water-Works." Between 1880 and 1890 he contributed largely to the editorial columns of the "Sanitary Engineer," and also wrote a number of articles on hydraulic subjects for Johnson's "Universal Cyclopedia." To "The Railroad Gazette" he has contributed a number of discussions and analyses of the traffic on the elevated railroads in New York city, with illustrative diagrams. He has been a member of the American Society of Civil Engineers since Dec. 4, 1867, was a director in 1876, the treasurer from 1877 to 1887, and vice-president in 1888. He is also a member of the Institution of Civil Engineers of Great Britain, the American Water-Works Association, of which he was vice-president in 1883, the New England Water-Works Association, the American Public Health Association, and of the Century and Union League Clubs of New York city.

SAMUEL T. WELLMAN.

Mr. Samuel T. Wellman, who was elected President of the American Society of Mechanical Engineers at the annual meeting held last month in New York city, was born in Wareham, Mass., Feb. 5, 1847. His father, from 1851 to 1878, was Superintendent of the Nashua Iron Co., of Nashua, N. H., and Mr. Wellman was educated at the common schools of Nashua, and then spent one year at the Norwich University, Norwich, Vt. He was later an apprentice in the machine shops of Messrs. Gage, Warner & Whitney, of Nashua; but, in 1864-5, he served in the Civil War in the 1st New Hampshire Heavy Artillery. After his discharge he was in the employ of the Nashua Iron Co. for about two years; and, while acting as draftsman and engineer he built the first Siemens gas regenerative heating furnace operated in the United States. The Messrs. Siemens sent an engineer from England to build and erect this furnace, who upon his arrival was surprised to find the furnace finished and ready for work. The immediate result of this achievement was an offer from this engineer, Mr. J. T. Potts, to assist him in the erection and starting of Siemens furnaces in other places in the United States; an offer which Mr. Wellman at once accepted.

Both for the Seimens and for their successors in the control of the American business, Mr. Wellman erected a number of furnaces, being mostly employed at Pittsburg, Pa. He then built and started the crucible steel melting furnaces of Anderson, Cook & Co.; others for Singer, Nimick & Co., and a pair of regenerative gas puddling furnaces for the Eagle Iron Works. In 1869, he was employed by the late Mr. C. P. Haughian, President of the Chrome Steel Works, of Brooklyn, N. Y., to build for this establishment a Siemens regenerative crucible steel melting furnace, which was so successful that he was engaged by the late Ralph Crooker, Superintendent of the Bay State Iron Co., of Boston, to design and build for them a furnace for melting steel on the open hearth.

This was practically a new departure, as the only furnace of the kind in the United States was a small experimental furnace erected at Trenton, N. J., by Cooper, Hewitt & Co., who had bought the American right to the Martin patent. The furnace built by Mr. Wellman for the Bay State Iron Co. was the first in the United States to make steel on the open hearth on a commercial scale. It was successful from the start, and was operated for many years. With this furnace the use of the ladle was abandoned, and the steel was tapped direct from the furnace, through a fore-hearth, into molds placed on a turntable located in front of the furnace. The stream of metal was regulated by a fire-clay-covered stopper, as in the ordinary steel works where the ladle was used. This fore-hearth has been lately applied, with great success, to the 50-ton furnaces of the Tennessee Coal, Iron & Railroad Co., at Ensley, Ala.

From the Bay State Co., Mr. Wellman went back to the Nashua Iron Co., and was its engineer and assistant superintendent from 1870 to 1873, his father still being superintendent. During this time he designed and constructed an open-hearth steel plant, a 3-roll plate mill and a bar mill for rolling merchant iron. In 1873 he went to Cleveland, O., to design and build the new works of the Otis Steel & Iron Co., including an open-hearth steel works, a plate mill and a large and a small bar-rolling mill. At his suggestion the late Alexander L. Holley was engaged as consulting engineer in this work. The whole management of these works was in Mr. Wellman's hands for 16

years, and he had much to do with establishing the high reputation of "Otis Steel." He rebuilt one of the furnaces in 1886, putting in a basic bottom made of magnesite imported from Carl Spaeter, of Coblenz, Germany; from this furnace, only operated for a few months, came the first basic steel made in this country. Owing to the great demand for their regular product of acid steel, the Otis Co. discontinued the basic process, against the advice of Mr. Wellman, who was much impresed with the process and prophesied its speedy adoption in the United States. To-day nearly all of the open-hearth steel produced in this country is made by the basic process by methods precisely the same as those used by Mr. Wellman at the Otis works in 1886.

On Jan. 1, 1889, Mr. Wellman became the consulting engineer for the Illinois Steel Co., and he designed the open-hearth steel works and plate-mill now running at the South Chicago works of that company. In 1890 he became president of the company, which bought the old works of the Chester Rolling Mill Co., at Chester, Pa.; but owing to the difficulty of remodelling an old establishment, a rapidly declining market and want of harmony among the stockholders, the venture was an unsuccessful one. Mr. Wellman then went back to Cleveland, and with his brother, Mr. Charles H. Wellman, and with Mr. John W. Seaver, he organized the Wellman-Seaver Engineering Co., which, as engineers and contractors, has done work in connection with steel plants all over the United States and in England, Germany, Spain, Russia, France and Japan.

Mr. Wellman has patented many of his designs; the most successful and best known being the Wellman hydraulic crane and an open-hearth charging machine. The latter device is said to have done more to lower the cost of open-hearth steel than any invention since Siemens patented his furnace; the direct saving to the users in the United States for the year 1900 is estimated at one million dollars; indirectly the saving is twice that amount. The Wellman gas producer is also well known, and hundreds are in use in the United States. The rolling open-hearth furnace is another of his devices; one of 50-ton capacity having been built at the works of the Illinois Steel Co. Mr. Wellman was also connected with the Solid Steel Co., of Alliance, O., since sold to the American Steel Casting Co., and with the American Wire Co., of Cleveland, O. Mr. Wellman is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the British Iron and Steel Institute, the British Institution of Mechanical Engineers, and the Verein Deutscher Eisen-hutten-leute.

CARL HERING.

Mr. Carl Hering, B. S., M. E., who was elected President of the American Institute of Electrical Engineers last spring, was born in Philadelphia in 1860. He is one of the sons of Dr. Constantine Hering, the founder of homœopathy in America, and is a brother of Mr. Rudolph Hering, M. Am. Soc. C. E., the well-known hydraulic engineer. Mr. Carl Hering graduated from the University of Pennsylvania in 1880, taking the degree of Bachelor of Sciences, and some years later that of Mechanical Engineer. In 1881 he was an instructor in mathematics and assistant in mechanical engineering at the same university; in 1882 he was assistant in physics and then began the study of electrical engineering.

In 1883 Mr. Hering was made a commissioner from the Franklin Institute to the International Electrical Exposition at Vienna, and was the only United States member of the jury of awards. In 1884 he undertook further advanced studies in electricity under Professor Kittler, at Darmstadt, and was soon after made the latter's assistant. In the same year he was the assistant electrician, under Professor Houston, for the Philadelphia Electrical Exhibition, and a member of the scientific commission for making tests and reports. In this capacity he urged the importance of a comparative life test of incandescent lamps and while this proposition was ridiculed by some, the test was afterwards carried out and remained for some years the only important one of its kind. In 1885 Mr. Hering became the chief electrical engineer for a German electrical company and then for one in Philadelphia, after which he commenced his present practice of consulting engineer.

The U. S. Government sent Mr. Hering to report upon the electrical exhibits of the Paris Exposition of 1889, and he was one of the United States members of the jury in the electrical class. For his services there the French government conferred upon him the decoration of "Officier de l'Instruction Publique." In 1890 he was appointed by the American Institute of Electrical Engineers as one of the three judges to award prizes at the St. Louis Electrical Exhibition of that year; and in 1891 he was chairman of the delegates of the American Institute of Electrical Engineers to the International Electrical Congress held at Frankfort, Germany, and was one of the Vice-Presidents of that Congress.

He was a member of the committee to prepare the preliminary program for the Chicago International Electric Congress. In 1892 he was for a time editor of "The Electrical World," and he was Vice-President of the American Institute of Electrical Engineers in 1891-93. In 1899 he was a member of the jury of awards at the Export Exposition in Philadelphia; and in 1900 he was one of the U. S. Government delegates to the International Electrical Congress at Paris, and a vice-president of that Congress; and he also represented the United States on the jury of awards at the Paris Exposition of 1900.

For about seven years past Mr. Hering has compiled and published in the "Electrical World" a useful weekly digest of current technical electrical literature, American and foreign; he has also presented a number of technical papers to the American Institute of Electrical Engineers and to other societies, and is the author of several books on electrical subjects.

ROBERT EMMET McMATH.

Mr. Robert Emmet McMath, who was elected President of the American Society of Municipal Improvements at its last annual meeting, was born in 1833, in Seneca county, N. Y. He graduated from Williams College, Mass., in 1857, and going West soon after that, became Deputy-Surveyor for St. Louis county, Mo., in 1859-62. In the latter year he entered the service of the U. S. Coast Survey on topographical and other duty. He continued in this service until 1865, and he was a member of the corps loaned by the United States to the State of Nicaragua for the purpose of surveying a trans-isthmian traffic route via the San Juan River, across Lake Nicaragua, and by a connecting railway line to the Pacific.

From 1866 to 1879 Mr. McMath was in the government service, acting as U. S. assistant engineer in charge of the improvement of the Illinois River, and later as principal assistant on the improvement of the Mississippi River, from the mouth of the Illinois to the mouth of the Ohio Rivers. In 1880-83 he was in the employ of the Mississippi River Commission, and made especial studies and investigations of the proposed reservoir system of control.

From 1883 to 1891 Mr. McMath was Sewer Commissioner of the city of St. Louis and a member of the Board of Public Improvements; he was in private practice in 1891-93, and in the latter year he was elected President of the Board of Public Improvements for the city of St. Louis, his present term expiring in April, 1901. Mr. McMath became a Member of the American Society of Civil Engineers on March 3, 1880.

THE RECONSTRUCTION OF THE UTAH CENTRAL RAILWAY.

By W. P. Hardesty,* C. E.

The old Utah Central Railway was a narrow-gage line, connecting Salt Lake City with Park City, and was 33 miles long. Park City is a rich mining camp on the east side of the Wasatch range of mountains. It is reached by a branch of the Union Pacific Ry., running from Echo on the main line, in a southerly direction up the valley of the Weber River, and thus securing a comparatively easy grade. But to reach Park City by a direct line from Salt Lake City, the Wasatch range must be crossed. This is done by this road by following up the canon of Parley's Creek to the divide, and thence descending the east side to the valley, near the head of which is located Park City.

*Progress Building, Salt Lake City, Utah.

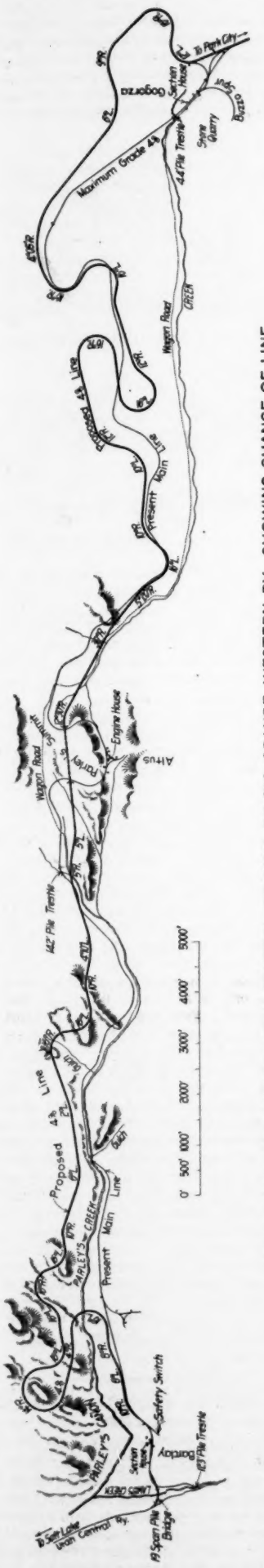
The narrow-gage line was built about 20 years ago. It has proven an exceeding difficult and expensive line to operate, the projectors seeming to place but little value on a road built for economical operation. Besides the excessive grades, there has always been much expense in contending with the deep snows every winter. It was never a profitable line, and in 1893 went into the hands of a receiver. Finally, early in 1898, it was purchased by the Rio Grande Western Ry. Steps were at once taken for its improvement. The new ownership gave it traffic connections that it entirely lacked before, and it soon began to make earnings that seemed to justify changing it to a standard-gage line, with all the radical alterations needed for a line with considerable traffic. Careful surveys were made, and in December, 1899, work was begun on the change of line here described. The new line extends from Barclay (about 16½ miles from Salt Lake City) on the west slope to Gogorza at the foot of the east slope. The distance between these two stations by the old line is 6½ miles. An inspection of the profile of the old line will show why it was necessary to lengthen out the new one. Beginning at Barclay, there are no grades going up to the summit of less than 3½%, ranging from that up to 6¼%, while grades of 5% to 6% are very common. There is a climb of 813 ft. in the three miles to the summit, or an average of 271 ft. to the mile. On the east side the grade varies from about 2½% to 4¼%, there being 667 ft. fall in the 3½ miles, or an average of 191 ft. per mile. Many of these heavy grades also came on sharp curves. The maximum curvature on the line was 20°. There were also three switchbacks on the west slope.

On the new line, the maximum grade is 4% on the west slope and 2.7% on the east one, compensated for curvature at the rate of .045 per degree. The maximum grade is continuous on the east side and nearly so on the west one. The maximum curvature is 16°, and there are many of this and of 14°. Considerable development is required on both sides to gain distance, and thus secure the reduced grade. There is much heavy rockwork on the west side, the material being used to make the adjoining high fills. On the east side most of the line is in fill, much borrowing being required. Fills are used on account of the great trouble on this side that was experienced with snow by the old line. The west slope is more exposed to the sun, though the snow becomes quite deep here, too. Probably 80% of the entire excavation was in solid or loose rock. There are 15 through cuts, the longest being 700 ft., and the average length 500 ft. There are 15 fills, the longest also being 700 ft., and the average 500 ft. The deepest cut is 55 ft., and the average 35 ft. The highest fill is 70 ft., and the average 35 ft. The old line is crossed once on the west side and three times on the east side, at grade.

SUMMIT TUNNEL.

The summit of the divide is about 19½ miles from Salt Lake City. The old line went over the summit at a grade elevation of 7,048 ft. above sea level. The new road is tunneled through the divide by a tunnel 1,116 ft. long. The summit of the grade is just beyond the east portal of the tunnel, 106 ft. lower than the old summit, and nearly 125 ft. lower than the natural summit of the divide. As shown by the map, the old line made a horse-shoe curve in going over the summit. The new line goes through it on a tangent, crossing under the old one near each portal. The divide or saddle here is not a solid formation, but seems to have been made by a slip from the adjoining mountains. Consequently, it is much faulted, and the ground is soft and loose. It is mostly shale or talc, with a little limestone—slippery and mean.

The superintendent of construction of the tunnel was Mr. C. E. Higbee, who has had an extensive


Maximum Grade 4%
44 Pile Trestle
Spring Quarry
Section House
To Park City
Wagon Road
CREEK
Present Main Line
Proposed 4th Track Line
PARLEY'S CREEK
Engine House
Switch
Section House
Station
Siding
42' Pile Trestle
To Salt Lake Union Central Ry.
To Spanish Fork
To Spanish Fork
To Spanish Fork

by the contractors, Mr. Higbee being retained as superintendent for it. About 600 lin. ft. of wall was built, all but about 100 ft. of it on the south side. Near the center of the tunnel about 100 ft. on each side was concreted. The settlement developed here after that of the 260 ft. before mentioned. Beyond the cave-in the ground stood firmly for some distance in.

reaching down to the lower parts of the posts. When a train was to be let through, the braces were taken out and the scaffold swung down next to the posts.

The slag used in the concrete was hauled from the smelters near Salt Lake City, and was made use of notwithstanding the long haul on account of the difficulty of obtaining sound, hard stone

in running the trains, while no elevation was gained.

As said before, the operating of the old line was exceedingly expensive. The heavier trainloads, consisting mainly of ore from the mines at Park City, are moved westward, for which reason it was necessary to have lighter grades on the east side. The most powerful engine on the narrow-gage

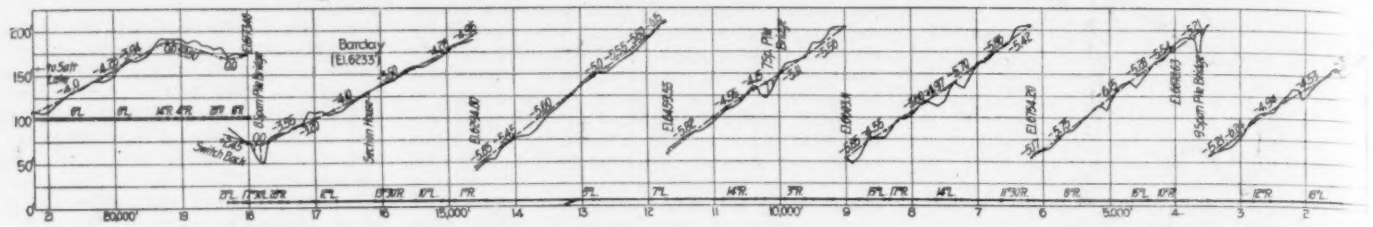


FIG. 2.—PROFILE OF OLD LINE.

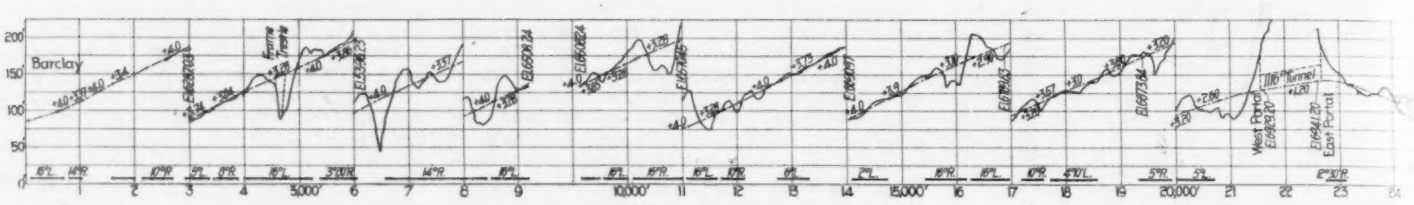


FIG. 3.—PROFILE OF NEW LINE.

The concrete was composed of Utah Portland cement, sand and broken slag in proportions of 1, 2 and 5. It was mixed on flat cars just outside the tunnel and then run in and used. The walls of concrete were made about 4 ft. thick and 17 ft. high. Where there were two, they were started about 14 ft. 6 ins. apart at the bottom and battered back until about 16 ft. apart in the clear at the wall plates. The lagging was taken from behind the posts, and the material then excavated for the desired thickness. It was put in in two lifts, the first one directly from the cars, the upper one from a scaffold. The excavation back of each post was first made; at the back of this an 8 × 8-in. post was set, and a short cap run from it to a support on the main post. A plank covering was put on these to catch the falling ground from above, and the excavation for the lift then completed. The posts were concreted in. It took about two cubic yards of concrete per lin. ft. of wall. If the original 16 ft. clearance between sides had not been lessened by the loose and wet ground forcing them in, the posts would be completely hidden by the concrete. The ground was excavated for 3 or 4 ft. inward in front of the mud-sills, and 14 ins. of concrete put in, coming 2 ins. over the sills. At the top the concrete was brought 1 ft. over the top of the wall plates, the lower end of the first segment of arch being thus concreted in. It was found here that the joint this segment made with the wall plate was one of the weak points of construction, the pressure inward tending to flatten the joint or angle, already too light on account of the slight angle at which the segment stands from the vertical. The pressure at the wall plate did not develop until after the timbers were placed and it was, of course, hard to anticipate in advance just what form of arch would be best suited. Mr. Higbee considers the 6-segment arch poorly suited for the character of ground found here, the angles at the joints being too flat to stand much pressure inward unless the same be evenly distributed. He thinks that, though looking much better than others, that when the pressure is uneven and heavy, tending to distort the arch, that this form should be displaced by the 3-segment arch. For the pressure usually found in tunnels (mostly vertical), the 6-segment arch is undoubtedly the best and strongest.

The wooden arch will rot in time, and will then have to be replaced with new timber or by a masonry arch. The concreting was done after regular trains had begun to run through the tunnel, between trains. The scaffold used for the upper lift of concrete was a swinging one, being hinged or hooked on to straps nailed on to the posts. The outer edge (it being 3 or 4 ft. wide) was supported by diagonal braces from the rock excavations on the line. Its use was cheaper than opening up a quarry nearby and hauling by wagons. It was broken up by hand, though not so fine as customarily.

TRESTLES.

There are some trestles on the line with unusual features. On the south side of the great loop north of Barclay is a high fill across a large gulch. As material was lacking to carry this fill up to the grade of the track, even after considerable borrowing, a trestle is used on top of the fill. This trestle has 16 spans of 16 ft. each. The bents gradually increase in height from the adjoining completed fill out, the 10 middle ones being of a uniform height of about 17 ft. to the grade of the track. To fill to grade here would require a fill about 70 ft. high at the center and 100 ft. high from the toe of the lower slope. The fill contains a large percentage of broken rock. The bents are founded on the fill as follows: Under each batter post are placed four pieces of 3 × 12-in planks, × 5 ft. long; crossways of this are placed two pieces of 6 × 8-in. timbers 4 ft. long. Under the two plumb posts are first placed four pieces of 3 × 12-in. planks 12 ft. long; and upon this are placed two 6 × 8-in. timbers 4 ft. long. On these foundations is then placed the regular 12 × 12-in. sill, running at right angles to the short sills next below them. The foundations have sides of plank nailed to them, running parallel with the bent, to keep adjoining material from running in on them when they settle. It was found that this fill settled 2 ft. before trains were run over the trestle, and the trestle bents have been gradually settling since then. The settlement is taken up by placing additional pieces of timber under the short cross-sills, the bents being first jacked up to grade.

About ½-mile above Barclay the line leaves the south side of the canon and crosses over to the west side, doubling back down the canon. The deepest part of the canon is crossed by a trestle of 16 spans, 248 ft. long. This trestle is on a 16° curve. At the end of the approach fill on the west side it is sloped down gradually, so that four or five of the shorter bents are founded on filled material in the same manner as for the other trestle. The track is 65 ft. above the bed of the creek below, requiring a three-deck trestle here.

The highest trestle is at the crossing of Lamb's Fork, the largest branch of the main creek. This was built to replace a switchback on the old line before the main change in the lines was began, and it is just below Barclay. It is a 19-span trestle about 300 ft. long, and is on a 16° curve. The track is 82 ft. above the creek below. This trestle is one of the scenic features of the line. The switchback referred to ran up Lamb's Fork for nearly ¼-mile. Considerable time was lost thereby

was one with 60,000 lbs. on eight 30-in. drivers, with a total weight of engine and tender of 116,000 lbs., and 16 × 20-in. cylinders. There were other engines with a total weight of 129,000 lbs., but only 55,000 lbs. on the drivers. Three loaded cars (weighing 20 to 25 tons each) were all that one engine could pull up the east side, and about two on the west side.

The locomotives now used are the consolidation engines, with 108,000 lbs. on the drivers, and a total weight of about 195,000 lbs. Up the 2.7% grade on the east side, one of these engines can pull 8 or 9 loaded box cars (weighing 90,000 to 95,000 lbs. each), and up the 4% grade on the west side about 5 cars.

The track is laid with 65-lb. rails, except for about 15 miles of the lighter grade, where the 40-lb. rails have not yet (Sept., 1900) been replaced. The 40-lb. rails cannot carry the latest large engines of the Rio Grande Western road (illustrated in Engineering News of Aug. 30 last), which have 169,000 lbs. on the drivers and a total weight of 295,000 lbs. Even the 190,000-lb. engines have to run slowly over the track where these rails are laid.

In addition to the radical change of line and the standard-gaging, there have been changes at other points, where bad curves have been straightened out. Most of this was done in the main canon, where the road lies near the bottom. The construction work has been done by the Utah Construction Co., of Ogden, which had an average of 500 men at work for several months. The main contract was completed early in June. Mr. Samuel J. Norris was the Engineer in direct charge of location and construction. He was immediately under Resident Engineer F. E. Baxter, who has had an extensive experience on location and construction of railways in the West. All the work was under the supervision of Mr. E. J. Yard, the chief engineer of the Rio Grande Western Ry.

The entire cost of the change and standard-gaging has been nearly $400,000. Regular trains began running over the standard-gage line about the last of July.

A 24-IN. VITRIFIED WATER CONDUIT AT HARTFORD, CONN.

During the year 1900, the water board of Hartford, Conn., substituted 16,700 ft. of 24-in. vitrified pipe for an open canal leading from reservoir No. 6 to the distributing reservoir. The work was described in a paper read, Jan. 8, before the Connecticut Civil Engineers' and Surveyors' Association, by Mr. Wm. E. Johnson, Engineer of the Hartford Water Board,

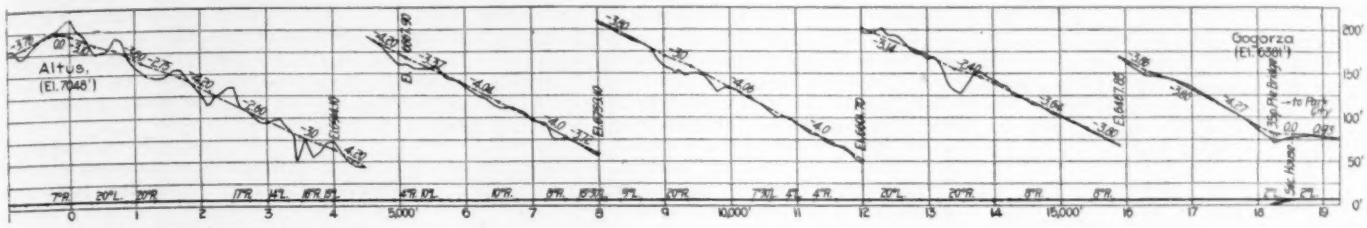
A closed conduit was chosen in preference to the

alternative plan of lining the canal. The conduit might have been laid in the bed of the canal, at a grade of 0.6 ft. per 1,000, but it was decided to adopt a somewhat longer route, designed "to utilize the entire fall of 50 ft. between the effluent pipe at reservoir No. 6 and the flow line of" the distributing reservoir. The route adopted gave a grade of 2.98 ft. per 1,000.

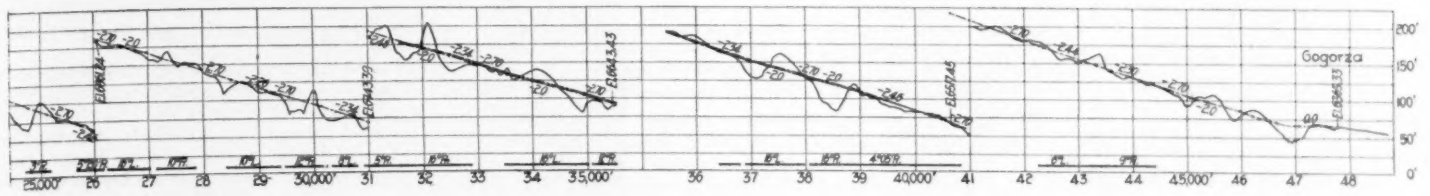
The back-filling was deferred until the cement had thoroughly set and a final inspection of the joints had been made. All openings or unevenness at the joints on the inside of the conduit were thoroughly filled with cement, thus securing one continuous smooth surface.

Special attention was paid to the back-filling under and around the pipe, tamping bars similar to those used in track work being principally used; the filling being carried to the top of the pipe and all thoroughly rammed.

figures are equivalent to 8.69 lbs. and 9.01 lbs., respectively, from and at 212° F. About 75 lbs. of coal were burned per sq. ft. of grate surface per hour and 6.5 lbs. of water evaporated per sq. ft. of heating surface per hour. The temperature of the smoke box varied between 721° and 785° F. In each of these tests nearly 16 tons of coal were burned.



UTAH CENTRAL BRANCH.



UTAH CENTRAL BRANCH.

The specifications called for the best quality of salt-glazed vitrified clay pipe, with a shell having a uniform thickness of 2 ins. and a socket not less than 4 ins. deep, nor less than 1¾ ins. in thickness, and with a mortar space of not less than ⅜-in., measured on the radius.

Bids were invited for pipe in 2, 2½ and 3-ft lengths. The contract was awarded for 3-ft. lengths, at $1.1975 per ft. The contractor was the Warner-Miller Co., of New Haven, but the pipe was made by the American Clay Manufacturing Co., at three different factories.

The pipe was laid entirely through private property, mostly wood and pasture land, in a 25-ft. right-of-way. The line is on the side of Talcott Mt., over rough and uneven country, with a minimum cover of 3 ft. To avoid sharp curves and save distance the pipe was laid on embankments, in a number of places, and for one stretch of 300 ft. it was laid below the uniform grade, the maximum depression being 9.65 ft., where three lengths of cast-iron pipe, on concrete piers, are laid over a stream.

Most of the curves had long radii, but there were a few of about 175 ft.

The remainder of the work may be described in the words of the author, as follows:

The trench had a bottom width of 4½ ft., no further excavation for bell holes at the sides of the trench being necessary.

The bottom of the trench was excavated, but without special care, slightly below the grade of the pipe; the grade and alinement for the pipe were obtained from a line of stakes driven in the bottom of the trench, one every 12½ ft.

At intervals of 3 ft., spruce blocks 2 × 4 × 15 ins. were thoroughly imbedded in the bottom of the trench, and at the same time the top of each brought to the required grade. This was accomplished by means of a cord stretched from one grade stake to the next; as the weight of each pipe was approximately 540 lbs., a light pipe derrick was used for lowering them to their position on the spruce blocks, the alinement between the grade stakes being trusted to the man in charge.

The pipe being placed in position its inner circumference was cemented with the preceding pipe and temporarily held in place by means of two hard wood wedges; the gasket having been cut into lengths sufficient to make one turn around the pipe, was worked back to the bottom of the bell in the usual manner, and the wedges removed. The outer surface of the spigot end and the inside of the socket were corrugated or furrowed, the object being to secure a larger amount of surface and consequently a better bond. The joints were filled with a mixture of equal parts of American Portland cement (Alpha brand) and clean sharp sand; as little water being used as possible. The cement was worked into the joints by means of rammers having a face 4 ins. long and 5-16-in. wide, and which were slightly curved to conform with the shape of the bell; the space at the ends of the bells being filled with cement, the finished surface formed approximately an angle of 45° with the surface of the pipe.

In this condition the trench was left until the completion of laying and the line put to its ultimate use.

At the foot of the slope at reservoir No. 6 a well was built and with this the 20-in. pipe leading from the reservoir and the 24-in. pipe conduit were connected; the well is of concrete, 8 ft. in diameter and 9 ft. in depth, the connection between the well and the conduit being a 30 × 24-in. reducer.

The depth of the water in the well is controlled by means of a gate valve placed on the 20-in. pipe. The length and grade of the conduit being as given its carrying capacity was calculated to be 8,600,000 gallons per day (N = .012), without running under a head. For a period of 30 days the drop in reservoir No. 6 and the rise in the lower reservoir were carefully noted, and other factors entering into the calculation considered. These figures would indicate that the conduit was discharging about 9,750,000 gallons per day. The work was done by the water board; the cost of the pipe line, not including excavation and back-filling of trench, was $1.4975 per ft.

SOME RESULTS OF EXPERIENCE WITH CORRUGATED FURNACES FOR LOCOMOTIVE BOILERS.

At the Junior meeting of the American Society of Mechanical Engineers on Jan. 8, Mr. Cornelius Vanderbilt read a paper describing the corrugated furnace type of locomotive boiler, introduced by him upon the New York Central & Hudson River R. R., and gave in addition some results obtained with locomotives having boilers of this kind.

The first locomotive built from Mr. Vanderbilt's designs was described and illustrated in our issue of Aug. 24, 1899. Since that date five more engines of this type have been built for the road above mentioned, and two each for the Union Pacific R. R. and the Baltimore & Ohio R. R. Some of the number were constructed by the Baldwin Locomotive Works and some by the Schenectady Locomotive Works. The later engines, especially those for the Union Pacific, are larger than the engine first built, but except for some minor features they do not depart much from the original design.

The results obtained in operation so far are considered very satisfactory. The cost of repairs upon the first engine during its first year of service amounted to $1,456 for materials and labor. A large part of this was for replacing a broken drive wheel and several other repairs which were in no way related to the boiler. Boilers provided with the corrugated fire box have shown less tendency to scale up than other boilers. The scale seems to be loosened by the alternate expansion and contraction of the corrugated fire box and falls to the bottom of the boiler.

In a number of economy tests made upon the road, fairly good results have been obtained. With 180 lbs. per sq. in. steam pressure an evaporation of 7.12 lbs. of water per lb. of coal was obtained in one instance and 7.38 lbs. in another. These

Following Mr. Vanderbilt's address, the process of making the corrugated furnaces was briefly described by Mr. W. E. Hill, Vice-President of the Continental Iron Works, of Brooklyn, N. Y. At first it was necessary to make the tubes in two lengths and then weld the parts together circumferentially. The corrugations were 1½ ins. deep. A new rolling machine has now been constructed which will roll a furnace 15 ft. long and will make the corrugations 2 ins. deep. The rolls are vertical. One roll is hoisted up out of the way, while the heated tube to be rolled is being placed in position by a crane.

THE OREGON LUMBER OUTPUT for 1900 is estimated at 900,000,000 ft. B. M. by Mr. A. J. Johnson, of Astoria. Last year's output was 600,000,000 ft. B. M.

THE BROWN PATENT ON ORE ROASTING FURnaces, No 471,264, dated March 22, 1892, has been sustained by the U. S. Circuit Court of Appeals, the decision being rendered by Judges Caldwell, Sanborn and Thayer in the appeal of the Metallic Extraction Co. vs. Horace F. Brown. The patent in question covered an ore-roasting furnace in which stirrers or rabbles are moved through the roasting chamber by an endless line of carriages moving through an adjacent chamber. The infringing concern built furnaces after the Ropp patent, No. 532,013, issued Jan. 1, 1895, in which rabbles were carried on carriages moving underneath the floor of the furnace. The lower court held that the Brown patent was entitled to a broad construction and that the furnaces of the Metallic Extraction Co., built according to Ropp's specification, were an infringement, and this decision has now been confirmed by the higher court. The Brown patent is controlled by Fraser & Chalmers, of Chicago.

THE CASE OF THE WESTERN UNION TELEGRAPH Co. vs. the Great Northern R. R., from St. Paul to the Pacific Coast, was decided on Dec. 22 in favor of the telegraph company by Judge Lochren, of the U. S. District Court. In 1882 the Northwestern Telegraph Co. sold out to the Western Union Co. 1,537 miles of line for $1,800,000 and a rental of $150,000 annually for 99 years. This line was built on the right of way of the St. Paul, Minneapolis & Manitoba R. R., now part of the Great Northern R. R. Contracts were entered into between the railway company and the telegraph company in 1879 and in 1882, by which the latter company supplied poles, wire, etc., and the railway company furnished transportation and labor for building the lines, and also provided operators. The case turned on the construction of these contracts. The railway company claimed that the telegraph company had no ownership; except as joint owner; and it asked that the telegraph company be compelled to accept the value thereof and abandon control to the Great Northern Co. The court sustained the claim of the Western Union Co. that it was the unmistakable owner through the contracts acquired with the absorbed company. The suit was commenced in 1897, and Judge Dillon, of New York, summed up for the Western Union Co. No costs were allowed for either side.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The description of the 24-in. vitrified clay water conduit, at Hartford, Conn., elsewhere in this issue, raises the question, why is not ordinary sewer pipe used more frequently in water-works construction? In this particular case the conduit is not under pressure, and was substituted for an open canal, from which there was a heavy loss of water by leakage. Of course, there was also some loss through evaporation. Aside from the saving in quantity there might be a great gain in quality by eliminating all exposure to contamination, where a closed is substituted for an open conduit. As between vitrified and cast-iron pipe, the saving in first cost may be partially offset by greater leakage from the former, which at best has four times as many joints as cast iron. But if some of the difference between the cost of cast iron and vitrified pipe be used to secure the highest possible grade of joints in the latter, and some of it be expended for larger pipe, a good margin will remain in most cases, where the pipe line is under slight or no pressure. This will be particularly true where the pipe line is not laid in a public street, and is not subject to disturbance by excavation. A possible great advantage for the vitrified pipe is freedom from corrosion, thus increasing the relative life of the pipe and lessening the chances of diminution in its carrying capacity. We should be pleased to hear of experiences, favorable or unfavorable, with either vitrified or cement water conduits.

Some commotion has been caused in Jersey City by the publication of the fact that a large number of property-owners are enjoying all the benefits of fire protection due to an ample water supply without contributing a cent to the expenses of the water department. There are nearly 10,000 buildings that are not connected with the water mains, but most of which are afforded fire protection thereby. The city officials appea'ed to their legal advisers to learn whether they could not levy a special fire tax on these buildings, only to find that they could not, since the highest court of the State had held that such a tax would be neither an assessment for benefit, nor a uniform property tax, and was, therefore, unconstitutional. The only recourse, it was held, is to appeal to the legislature for authority to levy a fire protection tax on all city property. This is not only good constitutional law, but, as we have pointed out more than once, it is equity. All property afforded fire protection by a water-works system should pay for it, regardless of whether water is used on the premises for domestic and manufacturing purposes. Under this plan, the aggregate charges to private consumers are lowered by just the amount involved in the general tax levy for fire protection. The same principle should be extended to other branches of the municipal service than the fire department, to the end that the total cost of the public service shall be borne by the city as a whole, leaving the balance of the expense to be distributed among the private consumers, in proportion to the amount of water used by each.

The consolidation of the anchracite coal-carrying roads, briefly announced in these columns last week, bids fair, if the latest reports are reliable, to be considerably more comprehensive than was at first anticipated. The press dispatches of the last few days have frequently announced that the Delaware & Hudson Co., which has for some time been classed as a Vanderbilt company, is soon to be formally leased to the New York Central & Hudson River R. R. The significance of this lease, should it prove true, is clearly brought out by statistics recently published in the "Coal Trade Review." On the basis of the percentage of the total anthracite coal production allowed the different roads, this journal compiles the tonnage of each Morgan and non-Morgan road, as follows:

Companies.	Output for 1899.	Per cent.
Morgan Roads.		
Reading	9,683,503	20.32
Central of New Jersey	5,392,530	11.31
Lehigh Valley	7,587,932	15.92
Del., Susq. & Schuylkill	1,694,467	3.56
Erie	1,949,876	4.09
Pennsylvania Coal Co.	2,347,081	4.92
N. Y., Susq. & Western	1,454,374	3.05
Total	30,109,763	63.17
Non-Morgan Roads.		
Del., Lack. & Western	6,372,401	13.37
Delaware & Hudson	4,132,659	8.67
Pennsylvania Railroad	5,159,102	10.82
N. Y., Ontario & Western	1,891,478	3.97
Total	17,555,640	36.83
Résumé.		
Morgan companies	30,109,763	63.17
Other companies	17,555,640	36.83
Grand total	47,665,403	100.00

As will be seen, the lease of the Delaware & Hudson Co. to the New York Central will leave only three anthracite carrying roads, viz.: the Pennsylvania, the Delaware, Lackawanna & Western, and the New York, Ontario & Western, which do not belong to the consolidation. Of these three roads the Delaware, Lackawanna & Western has been classed as a Vanderbilt road, and if long standing rumors are correct the Vanderbilt-Morgan and the Pennsylvania interests have been working in substantial harmony throughout the entire recent movement to consolidate the anthracite coal interests. This leaves only the New York, Ontario & Western Co. outside of the consolidation, which thus virtually controls over 96 per cent. of the total production of anthracite coal in the United States.

As our readers will recall, we have several times criticised the statistics put forth by the U. S. Road Inquiry Bureau respecting the alleged cost of bad roads to the people of the United States, and the estimated saving which could be made by the construction of "good roads." These criticisms are replied to by the head of the Bureau in a letter printed in our correspondence column this week. Instead of answering these criticisms, and thus giving the matter a controversial aspect, we shall try here to restate the salient facts in a very simple way.

First, the Bureau above named has published certain statistics of the cost of bad roads, and of the saving which could be made by the construction of good ones in the United States, and it has argued that good roads should be built as an investment, for the direct saving to the public and to the users of the roads which will result from the reduced cost of hauling over them.

We have criticised the correctness of these statistics and have held, and still hold, that they are wide of the mark; but the main point to which attention should be given is that any such statistics, based on general assumptions and broad averages as they must necessarily be, are not a practical or safe guide to the profit or loss on a particular piece of road work.

If a particular road is to be improved, the question is, will it pay? Will the people whose vehicles and merchandise will pass over this particular road receive enough benefit to warrant them in taxing themselves the amount of its cost? Averages of a nation or a state or a county may interest the statistician or the economist, but they tell nothing as to the profit or loss on a particular enterprise.

Now where transportation over common roads is carried on *as a business*, the direct return from the improvement of the road can be computed. There are thousands of such roads, where products of mines, mills or forests, are hauled to a shipping point, or where market gardeners and milkmen carry their products to towns and cities. Roads of this class, if only sufficient traffic is "in sight," can very generally be improved so that the reduced cost of transportation shall well repay the cost of the improvement.

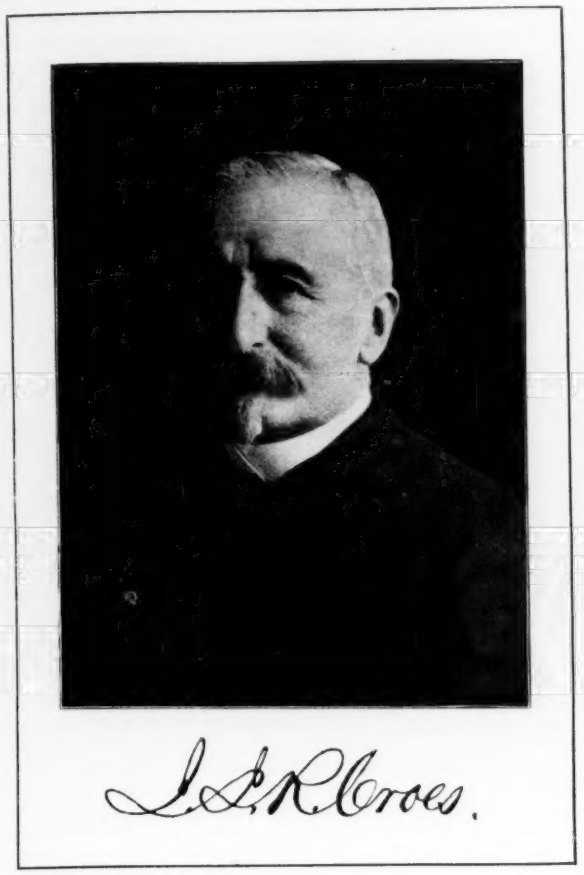
But on roads in the farming districts, remote from towns and cities—on country roads proper—there is very little of transportation *as a business*. The farmer carries most of his products to market at times when he and his men and horses would otherwise be idle. He would obtain benefit from good roads; but it is incorrect to measure it in the same way that we measure the benefit to the teamster, who, as a result of improved roads, can do his work with fewer horses and wagons, and who can thus afford to work at lower prices, so that the final benefit accrues to the public. It ought to be plain enough that no such benefit accrues in the case of the farmer. He will get the current price for his grain, whether he hauls it to market over a bad road or a good one; and as we have already seen, his total outlay for horses and laborers is fixed by his farm conditions, and not by the state of the highway to market.

The farmer understands this perfectly well. He is not for a minute deceived by the theorists who tell him that by taxing himself to pay for good roads he can put dollars in his pocket. He regards good roads as he does a covered carriage or a fine house or any other pleasant and desirable thing—as something very good to have when and where it can be afforded.

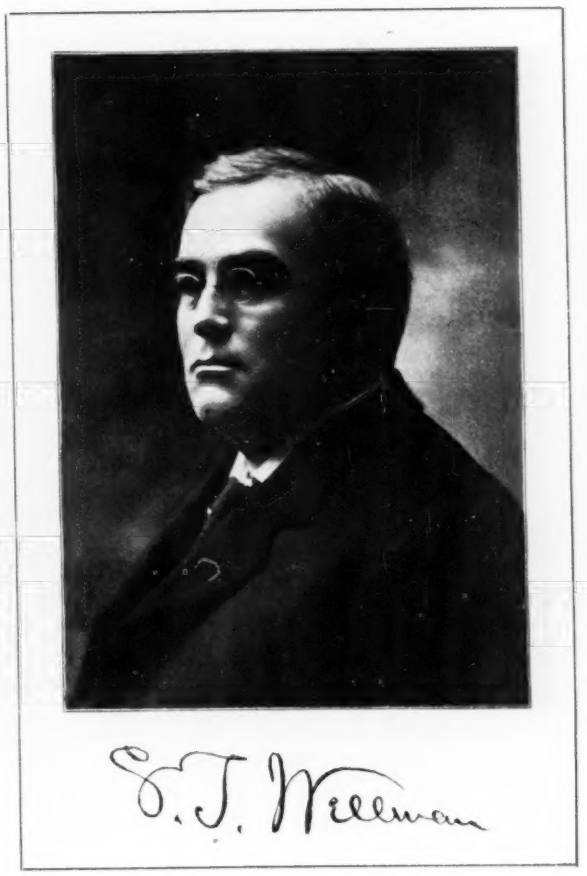
But, it may be said, what difference does it make whether good roads are a social or a financial benefit to the farmer? So long as they are a benefit at all, where is the harm in advocating their wholesale construction?

The harm, where harm is done, lies in the inducements to pursue a bad financial policy regarding good road construction which such statistics as those of the Road Inquiry Bureau hold out. It is good business policy for a man or a state or a nation to borrow money for an investment which will pay him a profitable return. It is bad business policy to borrow money to be spent on things which, however desirable they may be, yield no return. So long as good roads are built by direct taxation, there is no danger that more money will be spent on them than ought to be spent. The danger lies in building them with money borrowed on long time bonds. The State of Massachusetts, for example, has borrowed all the money which it has spent upon its system of state roads. Gov. Odell, of New York, in his recent inaugural message, urged that a similar policy should be pursued in New York in connection with a much enlarged expenditure for state highways. We do not say that such a policy is necessarily bad. We do believe that there is more or less of danger in it.

The work of highway improvement is not of

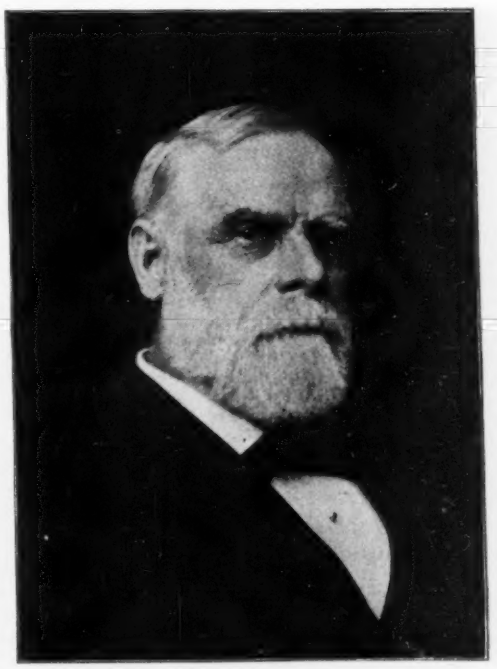


President of the American Society of Civil Engineers.



President of the American Society of Mechanical Engineers.

President of the American Society of Electrical Engineers.



President of the American Society of Municipal Improvements.

THE PRESIDENTS OF FOUR AMERICAN ENGINEERING SOCIETIES.

such a permanent nature that the money spent on it should be made a lasting obligation. If good roads are built with money raised by bond issues, the bonds should run for short terms only, otherwise the people may find themselves encumbered with a burden of debt after the roads for which the debt was contracted are worn out and require renewal.

Briefly summed up: The Road Inquiry Bureau's statistics tend to induce those unfamiliar with the facts to favor the incurring of public debts on a huge scale as an investment in the improvement of country roads. We claim that the returns from such expenditure will be indirect instead of direct; that good roads in farming districts are a luxury, and not a dividend-paying enterprise; and that where a burden of debt is incurred for such work, it should be merely to distribute the burden over a series of years.

AN OPPORTUNITY FOR CO-OPERATION BETWEEN ENGINEERING SOCIETIES.

The American Society of Mechanical Engineers has outgrown its house in New York city. At the recent annual meeting in New York, the attendance at every session was larger than the auditorium could accommodate. At the opening session, when the President's address was delivered, the whole house was filled, and not half those present were able to find room in the auditorium. A committee, appointed some time ago, reported at the recent meeting, it is true, against taking any steps toward the provision of larger quarters for the society; but their report does not alter the fact that in the one week of the year during which the society makes use of its house, it finds that building inadequate for its needs.

A little further uptown is the fine new house of the American Society of Civil Engineers, completed three years ago and representing a total investment of about a quarter million dollars. The society uses it on two days in each year for its annual meeting, and on about twenty evenings during the year for its fortnightly meetings. Is there any good reason why this commodious building should not be made a general headquarters for engineering societies in New York city, or why the Mechanical Engineers should not obtain in that house the quarters they need? The time when sentiments of rivalry should prevail in either society—if indeed there was ever such a time—has now passed. Each society has its proper field of work; the field of either would be in no way circumscribed if the headquarters of the two societies were located in the same building, and there need be no interference whatever between the two. As we have said above, each society holds its annual meeting in New York, but the date of one falls in December and that of the other in January. The Mechanical Engineers make no other use of their house for meetings during the whole year, save for the newly instituted Junior meetings, and these need not interfere at all with the regular meeting nights of the Civil Engineers.

We have said there are no reasons why the two societies should not co-operate in the use of a common New York headquarters. We would go farther, and say that there are positive and weighty reasons why they should do this.

Each of these two societies is now a highly prosperous organization. Each has a membership of above 2,000, and an annual income approximating $40,000. Some may claim, therefore, that there is no particular reason why these societies should economize. The Civil Engineers, without doubt, can go on and finish paying for their house from their surplus income, and the Mechanical Engineers, in the course of time, can build and pay for a house of their own, large enough for all their needs.

But because they can do this, does it follow that this course is the best one? We believe we voice the sentiments of the great bulk of the members of both societies when we say that the society funds should be put to such uses as will result in the largest benefit to the society's members; and that the needless multiplication of society houses in New York city to stand idle most of the year is not such a use.

The investment necessary for a suitable building for either society in New York city will approximate a quarter of a million dollars. The interest, depreciation, insurance, and taxes, added to the cost of heating, lighting, etc., will make the annual charge against such an investment not less probably than 10%, or a total annual expense of some $25,000, as the cost of keeping up such a house in New York city. More than half the members of either society live too far from New York to make any use of the society's headquarters there. In fact, there was years ago considerable sentiment in each society against investment and expenditure on a New York house; and in the Civil Engineers this sentiment is still recognized in larger dues for the members residing in or near New York city.

The value to the society as a whole of permanent headquarters at what is unquestionably the engineering center of the country, is now well recognized; but the burden for this purpose on the membership at large ought to be made as light as possible. If by co-operation between the two societies in the use of the present house of the Civil Engineers a substantial sum could be saved annually to the treasury of each society, it seems to us the manifest duty of the respective governing bodies to bring this about.

And now for something else in the way of plain speech: It is too commonly said and felt by many members of each of these societies that the individual members have little voice or responsibility in the conduct of the society's affairs. The managing officers run the society, and the individual member pays his dues, and receives in return his copy of the "Transactions" and whatever professional honor and personal satisfaction accrue from his membership.

With the rapid growth in membership of these two principal national engineering societies, the funds at the disposal of each governing body have largely increased, and will increase still more in the future. Should the members so desire, the way might easily be opened by the form of co-operation we have outlined, for a substantial reduction in the annual dues—and we know that to a large proportion of the members of both societies the annual dues are by no means an inconsiderable burden. If, however, the members prefer—and the members themselves and not the governing body should decide this question—this added income should be devoted to new purposes by which the societies can render still larger and greater service to their members.

There are fields and opportunities not a few where the society—the members acting together—can do for the profession and for each member of the profession what the members acting individually cannot do for themselves. One example of such work already undertaken by the Civil Engineers is the complete indexing of that society's library, the plans for making it available for non-resident members, and the plans for making it the complete repository of professional literature that it ought to be. Other work might easily be named, which the surplus funds, that would be placed in the societies' respective treasuries by the above-suggested co-operation would render possible; but to describe such projects in detail would lead us too far afield.

We may say the same regarding other features of co-operation between the two societies, noting only that the suggested co-operation in the use of a common house might easily be the entering wedge for other forms of co-operation that should be mutually beneficial to the members of both societies.

The fact may not be generally known that a very considerable number of engineers already hold membership in both societies, and in this number are included many of the most prominent members of each. With this state of affairs, why should the governing body of either society hesitate to make the necessary advances toward co-operation?

In conclusion it may be said that we write with no knowledge as to the sentiments of the present governing bodies of either society toward such a scheme for co-operation as we have outlined. Individual members of both societies, however, have expressed their enthusiastic approval of such action, and we shall be glad to receive the opinions of others.

LETTERS TO THE EDITOR.

A Prohibitory Tariff on Beet Sugar Imports from Russia and American Exports of Manufactured Goods.

Sir: The Ingersoll-Sergeant Drill Co. desires to call your attention to a matter which has recently come to their notice and which they think might prove of interest to the patrons of your esteemed paper. An effort is being put forth by the beet-sugar interests of this country to prevent the importation of beet sugar from Russia by having the Secretary of the Treasury abrogate the clause in our present reciprocal arrangements with Russia, wherein the said sugar is brought into this country under the favorite-nation rate of duty. This will prohibit any further imports of sugar from Russia by putting in force the tariff of the Dingley bill against said sugar, which will with the internal revenue tax, if the sugar manufacturers of Russia must buy their own goods, effectually put a stop to any further importation from that quarter. While the Ingersoll-Sergeant Drill Co. does not contend that the beet-sugar interests shall not have the widest possible scope in the exercise of their rights, we do, however, maintain that it is the duty of every American manufacturer to take warning as to how his own interests are to be effected by this proposed action.

If the Secretary of the Treasury carries out the arrangement which has been proposed, and which we believe is suspended for about sixty days, it will be promptly met by retaliation from Russia in the shape of an increase in duties against all classes of American manufactured goods, ranging from 25% to 30%. This will be in effect also prohibitive as to any further exports from this country, and there will be left in the lurch hundreds of American manufacturers, with half complete orders on their hands and a new basis of estimates as to expenses which can hardly be met by increase of numbers, as many of the goods which are now being made in American factories to be consumed in Russia have been arranged for by specific contracts, which contracts take no account of course of the changes in existing tariff, such changes being entirely unexpected.

You have, we assume, the fullest access to the tables of the Treasury Department as to imports and exports, but if our source of information is correct the total value of sugar imported from Russia during the fiscal year ending June 30, 1899, was but $340,000, while during the same period this country sold to Russia manufactured goods amounting to $10,000,000. We are told that during the first ten months of 1900 we sold to Russia $9,440,000 of goods. This, of course, means goods sold direct and going into Russia via the Baltic and Black Sea ports, and takes no account of the millions of dollars worth of goods which have been imported into Russia via England and Hamburg.

It is our belief that the National Association of Manufacturers of America should form committees and deputations, and every company or private concern, whether a member of this association or not, should in every way possible prevent the consummation of this very radical action. The public should be informed, if it does not already know, that upon the completion of the Trans-Siberian Railway system the field which will be offered in Siberia for American machinery of all kinds will be unprecedented. You are, of course, aware that under our present arrangements all articles manufactured in this country are admitted absolutely free of duty to the port of Vladivostock and other Asiatic ports of Siberia and Russia.

We are writing you on this subject, as we have written the National Association of Manufacturers of America, hoping to have your co-operation and interest in giving the manufacturers of America the fullest possible warning before this radical action is taken by the Treasury Department at Washington. Our interest is to encourage and not discourage foreign governments to admit American manufactured products free of duty, and this measure to which we have referred if carried out will seriously curtail opportunities for doing foreign business. We would therefore like to have the co-operation of the scientific press in preventing this action. Cordially yours,

The Ingersoll-Sergeant Drill Co.,
W. L. Saunders, Vice-President.

New York, N. Y., Jan. 11, 1901.

The Possibilities of a State Electric Freight Railway as a Substitute for a Barge Canal from Buffalo to the Hudson River.

Sir: It is generally understood that the report of the state engineer in regard to the enlargement of the Erie Canal will be presented to the Governor about Feb. 1, 1901. Before any action is taken upon that report, would it not be well to consider the possibilities of replacing the canal by an electric freight railway? The development along the lines of power transmission and electric motors has been so rapid during the last few years that very few realize the results that can be accomplished with present conditions.

Anticipating the necessary result of the investigation by the state engineer and his associates into the cost of a barge canal, that such canal will be found too expensive for the benefits received by the people of the state of New York, however favorable it might prove to our neighbors on the west, also impressed by the statement of the presi-

dent of one of the leading railroads made about the time this barge canal was proposed, I have been examining the possibilities of an electric railway on the canal right-of-way. If a barge canal can be built for $65,000,000 (which I believe will prove impossible), the ordinary repairs of such a canal will amount to at least $2,500,000 per year. During the first years of its operation extraordinary repairs, on account of breaks accompanying all works of such character, will amount to another million at least. The land and damage claims for the $9,000,000 improvement have amounted to over $2,000,000 during the past year, and are still coming in. The barge canal can safely be relied upon to treble these claims. If the barge canal could be built, it could benefit only the New York terminal, and Buffalo would become largely a way station, as vessels would gradually be built to make the through trip from western ports. No interior city could be benefited, as the carrying capacity of the barges would be too much for the needs of local manufacturing plants, and after the boats now in use are worn out it would not pay to build small boats to operate by electricity, and the towpath will necessarily be abandoned to the use of electric conductors. The barge canal cannot be built without interfering with the use of the present canal for at least two years.

The state of New York has unlimited water power at Niagara; it has 70-ft. head at Lockport for all the water it can carry to that point; it has 90-ft. head at Rochester, with the great storage reservoir at Portage at its command; it has 800-ft. head at Rome on the Black River Canal, with large storage capacity in the Adirondacks; it has 40-ft. head at Little Falls on the Mohawk River; it has 200-ft. head in the Mohawk River from Schenectady to Troy which can all be utilized, with storage reservoirs on Schoharie Creek, and East and West Canada Creeks. Economical transmission is now possible at 50 miles, and will probably soon reach 75 miles. Thus, it will require but two stations on the Hudson River, one about Fonda on the Mohawk, and one between Syracuse and Rochester, to be operated with steam with coal for fuel. Even in these last districts there is considerable water power controlled by the state that can be used.

A railway on the canal right-of-way would traverse the entire state without a grade crossing, and by constructing a tunnel four miles long southeast of Schenectady, freight can be hauled from Buffalo to New York and raised less than 50 ft. in the entire distance, and part of this amount of elevation is only required to modify the grades in Rochester, Syracuse and Utica. The state owns admirable terminal facilities in the city of Buffalo. In New York the city authorities would gladly devote the piers from 50th St. to 59th St. for a terminal. These, with ultimately an elevated freight track in Greater West St. to Cortlandt St., when the northern extension of that thoroughfare is completed, would give satisfactory terminal on that great harbor. The three electric locomotives of the Baltimore & Ohio R. R. have been in constant service for several years and have proved a complete success. These locomotives haul 35 loaded cars up a 42-ft. grade at the rate of 15 miles per hour, and, running light, have made the trip through the tunnel at 68 miles per hour. These locomotives, on such a grade as can be built from Buffalo to New York, could haul 50 pressed-steel cars with a capacity of 50 tons live load, 2,500 tons of freight per train, and the average work with such freight as has been handled by canal could average 2,000 tons live load per train, not six months, but twelve months, in the year.

A double-track railroad, with middle passing sidings, handling only car-load lots, estimating on a basis of 8,000,000 tons east-bound and 2,000,000 tons west-bound freight, allowing the railway, with equipment and terminals, to cost $100,000,000, could move freight for less than $1 per ton, or 5 cts. per hundred, 3 cts. per bushel, car-load lots, at owner's risk, whether sixth class or first class. We can better appreciate what this means when a local rate could be made so that Rochester manufacturers could ship freight to New York for 4½ cts. per hundred, Syracuse 4 cts., Rome and Utica 3½ cts., Amsterdam and Schenectady 3 cts., and Kingston and Newburgh 2 cts. per hundred; or, in the case of the latter cities, for a less amount per ton than it costs the coal dealer to deliver a ton of coal to a private residence anywhere in the city. All kinds of grain could be inspected in cars and sealed up at Buffalo and delivered directly by car floats to shipping in the harbor. With adequate terminal facilities at Buffalo and New York the harbor and terminal charges at both ends could be reduced at least one-half. Allowing the railway, with the equipment and terminals, to cost $100,000,000, the state can borrow this sum at 3%, making first charges $3,000,000. This amount would be made from the earnings of the railway, and after the term of five years a sinking fund could be established, which would gradually pay off the entire bonded indebtedness. The gross outlay by the state for the railway would be the interest on the bonds issued during the two years the road would be under construction, amounting to not more than $4,500,000. If, upon careful investigation, it should not be considered desirable for the state to operate the railway, the boards of trade of the different municipalities through which the road will run could organize an operating company to lease the road from the state and operate for the benefit of the people, thus reducing the freight still lower when earnings would justify it, for in a few years this road, with three tracks and sufficient sidings, could handle a business of 30 to 40 million tons per year. Or, the road could be leased and operated for a term of years in a manner similar to the Underground Rapid Transit Railway in New York city. This latter method of lease could not be made as elastic as the former. The people of the state already own and lease a railway, so there is no precedent to be established. No sympathy need be wasted on existing roads, as they are helping to divert business, which naturally belongs to New York, to other ports. Notably, the New York Central has just agreed to improve its Boston terminal, and charges as much to haul a bushel of grain from Albany to New York, 143 miles on the level, as it does to haul it 202 miles over the mountains to Boston.

J. H. Ehrehart.

New York, N. Y., Jan. 7, 1901.

Facts and Fallacies Concerning Good Roads.

Sir: I have read the editorial on the good-roads question in your issue of Nov. 15, and the report of the Good Roads Congress in your issue of Nov. 29. I note that you divide your editorial criticism into two parts: the first pertaining to fallacies, and the second to facts. I find myself in accord with most that you say under the head of facts, because it is in this connection that you discuss the policies which should be pursued in reference to the improvement of our highways.

The whole subject naturally divides itself into two parts: (1) the consideration of how much of a burden upon industry is caused by bad roads; (2) a consideration of the means by which we can remove or diminish that burden. If the burden is small, there is less necessity to remove it, and it could be easier done. But if the burden is large, the difficulty of removing it will be proportionately greater. My own opinion is, and long has been, that the burden to industry resulting from bad roads is much greater than is commonly appreciated, and I think the slow progress made in the improvement of our highway system is explained more by the difficulties to be overcome than by what you claim is the imprudent zeal of the friends and advocates of good roads. I am not standing, as you seem to suppose by reference to my remarks made in Chicago, for the absolute accuracy of everything that has been published with a view to showing that the burdens to industry are very great in consequence of bad roads; but I am fully satisfied that these burdens are substantially as great as they have been represented to be. The components of cost in transportation by animal power are very numerous, and some of them very great. It is quite possible in making an estimate of cost per ton per mile that some of these factors have been considered to be larger than they are; but it is equally as probable that others have been considered as less than they really are; while it is absolutely certain that some of the components of cost in every estimate have been entirely omitted. So that the result of a computation is not necessarily vitiated, as you assume, in case one or more of the components are shown to be too large.

By reference to Prof. Baker's article, which you recommend so highly, I notice that he has committed all the errors which he complains of in others, and has gone beyond them by adding contradictions to inconsistencies, and by drawing false and harmful conclusions from premises neither admitted nor established. He begins by expressing the opinion that the advocates of good roads have injured the cause by overestimating the loss that results to the country by reason of bad roads. But he ends by giving a list of 14 advantages which he says may be secured to the people by building good roads. He claims that too much attention has been given to the supposed financial advantages of good roads, and yet out of his list of 14, the first 8 (he says) are financial, and the last 6 are social. He excludes the increased value of land as one of the advantages resulting from good roads, on the ground that the increase represents both the financial and the social advantages combined. So it would appear, after all of his objections, that he joins the others in thinking that social advantages have a financial value which expresses itself in the increased price of land.

It is in this connection that he tells us that farming land in the corn belt of Illinois, within one mile from a railway station, sells for as much as $10 per acre more than land five miles farther away. He says, "strictly the above sum is a little more than the supposed value of good roads." He then assures us that the above sum is too small to justify any radical highway improvements. But $10 per acre is equal to $6,400 per sq. mile, which is a sufficient sum to build a good hard road on every side of every quarter section of land in any given territory, at a cost of $3,200 per mile. The estimated area of farms in the United States, according to Prof. Baker's article, is 1,000,000 sq. miles, which at $6,400 per sq. mile would equal $6,400,000,000. This is a little more than ten times as much as Gen. Stone's estimated possible annual saving according to circular No. 190 of the Office of Public Road Inquiries. He objects to the approximations made in the circular, and complains because Gen. Stone did not extend his investigation over a wider field of inquiry; and yet the Professor expresses great confidence in his own conclusions, confessedly based on a much narrower field of observation, and at variance, so far as I know, with all other investigations of this subject. He claims that Gen. Stone's conclusions should be discarded on account of the narrowness of the field, although they covered the whole country; and wants his own conclusions accepted, notwithstanding the fact that he has not extended his investigations beyond the corn belt of Illinois.

He complains of the unreliability of the answers received by Gen. Stone to the questions in the 10,000 letters sent out by him, on the ground that the correspondents might not have been sufficiently instructed as to how to frame their answers. Yet he has no hesitation in resting his own conclusions on the testimony of a few grain farmers, who tell him that it costs about 22 cts. per ton a mile, and a little later in the same interview, that it costs nothing. On the matter of the average haul the Professor thinks that Gen. Stone made a mistake in getting the average distance hauled, instead of the average haul. Then he proceeds to give the true rule with mathematical accuracy, and applies it as follows: "For example, Illinois has an area of 56,600 sq. miles, and has 10,752 miles of railways, exclusive of sidings and second tracks; or 1 mile of railway for each 5.3 sq. miles of area. Investigations also show that the distance between railway stations averages a trifle under 4.5 miles. Therefore, if we consider a strip of land 5.3 × 1 miles laid transversely across the railway half way between railway stations, then the maximum haul will be approximately ½ of 5.3 + ½ of 4.5 = 4.9 miles." This, of course, gives the maximum distance, and not the maximum haul; the very thing which he complains of in Gen. Stone. He not only makes the same error that he complains of, but he adds at least two more in this one example., The first error, and it is a gross one, is in supposing that the distance from circumjacent territory to railway stations can be determined by dividing the area of the state by the number of miles of railway in it. The second one is in supposing that the distance hauled will diminish as railway tracks approach each other. Railway tracks converge as they approach the great cities, but it is just here that the wagon haul is lengthened, as the following (taken from the Maryland Highway Report) will show: "Around large cities, it will usually be found that the limit of the practical hauling distance is considerably greater than in sections remote from urban influences." They place that distance at from 14 to 20 miles. I will quote the following from Prof. Baker's article: "The distance will vary greatly with the locality. Farm products will be hauled much further to a large city than to a small village." So the last error is worse than the first.

Touching the average cost per ton per mile which the circular gives as 22 cts. for the Prairie states, and 25 cts. for the United States, the professor complains that "no details are given as to the method employed." It would be difficult to give a detailed statement of such a complicated process in a brief communication. As I said above, the components of cost are very numerous, and they also vary greatly with the varying conditions. We have to consider distance, speed, grade, surface of roadbed, weather, season, heat, cold, rain, snow, length of day, kind of vehicle, size of vehicle, weight of load, time required for loading and unloading, value of service of same, kind of animals used for power, number of trips per day, prices of animals, wages of laborers, cost of living, cost of feed, total quantity to be hauled, returning empty, going with partial loads, emergency loads, wear and tear and various other items which do not occur to me at this minute.

I consider the proper solution of this complicated problem as the key to the whole controversy. It is not likely that every one would follow exactly the same method in ascertaining the cost per ton per mile. The method which I pursued myself is set forth in my testimony, given before the Industrial Commission at Washington, in June, 1900, from which I quote as follows:

I have been interested in the subject of the improvement of roads since 1891, and have been studying the subject continuously in connection with other matters from that time on. I published a pamphlet in 1891 that was the result of some former investigations made, but nothing so very definite until that time. Since that time I have been engaged partly on my own account and partly for the state of Ohio and partly for the United States. In 1893 I was appointed by Gov. McKinley to represent the state of Ohio on the general matter of road improvement, and especially in reference to any changes that might be suggested in new methods of building, and application of new power or vehicles, and also the cost per ton per mile of moving by the usual methods prevailing in the country districts with ordinary vehicles and animal power. There never had been up to that time, I think, any statement or publication of the cost per ton per mile by animal power. We had through the railways and through the transportation companies very accurate information with reference to the cost per ton per mile by the railways and by the steamships, but I think there never had been a publication as to the cost by animal power. I took the matter up for the Commission of Ohio at that time, partly for the purpose of comparison to see whether there had been the same improvement in the means of transportation over the common roads that had been manifest by other means of transportation. The result of that investigation showed that the average cost per ton per mile by animal power was about 25 cts., but that the cost by steam cars was only ½-ct. In other words, that you could carry 50 times as far at the same cost upon steam cars as you could upon the common roads; and further comparison also showed that a still cheaper rate prevailed upon the Great Lakes by steamship, and that 1,000 miles could be reached at the same cost as 250 miles with steam cars or five miles with animal power. To put it per ton per mile, it was only one mill per ton per mile for moving upon the average on the Great Lakes, five mills upon the steam cars, and 25 cts. per ton per mile upon the common roads with animal power.

The investigation that I made at that time was the first official investigation ever made. Before that time I had made some investigation on my own motion, because I felt interested in the subject. I had had a very large experience in handling many of the products, and had acquired an actual knowledge of the cost as I considered it, in my own experience, and I enlarged that to the experience of others by inquiry. I also ascertained at that time, through the Mexican minister, Mr. Romero, that the cost per ton per mile in Mexico was 26 cts., and I made use of that for comparative purposes, the result of which seemed to show that there was not very much difference in the cost of transportation by animal power in our own country and in Mexico.

I took into consideration all kinds of roads, from the poorest to the best, from the long haul to the short haul—all of the distance ordinarily covered; and that is why I took this matter of Mexico, because for several hundred years they had been transporting all of their imports from Vera Cruz to the City of Mexico, a distance of 272 miles, and it furnished a very good test of the cost upon the long haul. I also compared the cost of transporting over the plains before the railways were built, and I found that it was fully as high on the long haul there. Then in the country I took the ordinary long hauls, varying from one to ten miles, and reduced it to tons per mile to get at the result.

In northern Ohio, where I live, it is a dairy country. The milk of the farmers, which is their largest product, is taken either to the railway stations for shipment, or to factories to be made into cheese or butter. The contract is usually let to the lowest bidder to gather this milk in what they call milk routes, beginning at the most distant place and gathering it up as they approach the cheese factory. It was easy, by getting at the tonnage from the cheese factories and the prices, to reduce it to tons per mile, which I did in many instances, and the quotient was almost a constant factor. Then after the cheese was manufactured in these cheese factories, it was hauled to the railway station, and there again was competition, and it was let under such terms that it was easy to convert it into tons per mile. Also in that country in the last decade there has been a great deal of timber sold and taken away, sometimes in the shape of lumber and some times as timber. In most cases it was hauled for so much per thousand feet, but that was easy to convert into tons per mile, and having obtained these facts on the various kinds of roads and various distances, I deduced the result which I have stated. Then for the shorter haul, in the city of Cleveland entirely on paved streets, or nearly so, I confined my investigations to the heavy material, such as brick, stone, lumber, and building material, such as are furnished and delivered at so much a thousand, or so much a ton. Converting that into tons per mile I found that it was close to the same average.

Occasionally I would find that the rates were as low as 15 cts. a ton per mile. That was the minimum. In many instances it would go 50 cts. a ton a mile. Now, this that I speak of was not under any contract for full loads, but where there were partial loads, and very bad roads, it would go to about 50 cts., and the average on the whole was about 25 cts. per ton per mile. In 1893, I first published this result, which I believe to be the first table ever published in this country or anywhere, so far as I know, giving the rate per ton per mile of transporting on the common roads by animal power.

Although Prof. Baker complains that Gen. Stone gives no detail of the method employed in determining the cost per ton per mile, he nevertheless concludes that the General's method must be wrong and his conclusions therefore erroneous. Whatever difficulty there may be in the solution of the problem, or whatever obscurity is involved in Gen. Stone's method of investigating, the Professor leaves us in no doubt as to the simplicity of the method employed by himself, which he gives in the following words: "In many localities there is a choice of markets, and in central Illinois it is nothing uncommon for a farmer to haul corn four to six miles extra for a difference of 1 ct. per bushel; 36 bushels make a ton, and therefore he receives 36 cts. per ton for the extra hauling, or say 6 to 9 cts. per ton-mile. This result is approximately one-third of that in Table I (of the circular)." This method certainly has the merit of simplicity, but it lacks the element of reliability. So many components of ordinary cost are omitted that the result is the minimum with no allowance for loading and unloading; while the proper solution of the problem requires the average cost per ton per mile considering all the varying conditions over a great extent of territory, including the components of loading and unloading. It is not likely that the small sum of 1 ct. per bushel for oats is any more than enough to cover the cost of loading and unloading under all the varying conditions, to say nothing about the cost of transportation.

Continuing, the Professor says: "The most important error in the whole investigation under consideration is the assumption that the chief business of the farmer is transporting his crops to market." Prof. Baker is the only investigator, so far as I know, who makes that assumption. On the contrary, we know that the farmer's chief business is not that of transportation, and that he carries on that part of his work with great difficulty and often with unnecessary expense. Those who have read the hornbook of economics understand that the power of production is greatly increased by the division of labor and the application of machinery, amounting in many instances to tenfold; and that the same principle also applies, to a very great extent, in transportation. We, therefore, know that whatever errors we may make in determining the cost per ton per mile by animal power as usually applied by farmers in agricultural regions may be corrected by means of a comparison with the cost to those whose principle business is that of transportation by animal power over the common roads; always knowing that the cost so ascertained is sure to be lower than the necessary cost to farmers generally who cannot take advantage of the division of labor. Take a million farmers, all of whom are obliged to engage for a portion of their time in the business of transportation, and they will have to have a million outfits consisting of several million vehicles of varying sizes and shapes, with horses, harness, and tackle; all procured and maintained at great cost, always used under circumstances of disadvantage, and much of the time entirely unemployed. It is likely that 10,000 persons, taking advantage of the well-known principle of division of labor, and the application of machinery, could perform the work of transportation now done by the million.

In the light of this principle it becomes important to get the testimony of those who have actual knowledge of the cost obtained from actual transactions. I remember in a former discussion of this question in your paper, that you asked for such information, and received two letters as follows, which you published Jan. 16, 1896:

Sir: In your estimate (Engineering News, Dec. 5) of the cost of hauling produce, etc., on common roads, I think you consider the wagon to be loaded both ways, which is seldom the case in this kind of hauling. While on construction of the Santa Fe R. R. in Oklahoma, I paid 1 ct. per 100 lbs. per mile (20 cts. per ton. per mile). This was the usual price for freighting provisions, as they could only load one way. Geo. M. Walker, Jr.

Argentine, Kansas, Dec. 10, 1895.

Sir: I have been very much interested for the past ten years in the good-roads problem, consequently I was very much interested in the articles in your issue of Dec. 5 and 19 on this subject. In your issue of Dec. 19 Mr. William Haelig has given an estimate of what it costs per ton to haul freight over good roads which is certainly a very good showing, I think. In your comments you express a desire to know what was charged by four or six-horse freighters of half a century ago. I cannot go back so far as 50 years, but I can give you what the freight charges were by four-horse freighters in southwest Virginia from about 1878 to 1883. For years previous to 1883 my father owned and operated four-horse freighters between Keysville, Va. (which was the nearest railway station), and Chase City, a distance of 20 miles. That is, it was 20 miles during the good-road period, but in wet weather it was considered 40 miles, and rightly so, I think. His rate for hauling was 25 cts. per ton per mile in the summer and fall, but when the roads got wet and muddy in winter the rate was raised to 30 cts. per ton per mile, and I have known it to be as high as 45 cts. per ton per mile. My father often told me that at this rate he only made a fair return on the money invested. In dry weather a four-horse team could only draw about 4,000 lbs., and I have known the roads to become so horrible that a four-horse team could not drag more than 1,500 or 1,800 lbs. At the foregoing rates per ton per mile, the average corresponds very closely to the average given to the middle Southern states by the Agricultural Department. J. C. Nelson,

Engr. Maintenance of Way, "Big Four Route."

Springfield, O., Dec. 27, 1895.

I have just received a letter from James W. Abbott, a mining engineer, and expert road builder, of Lake City, Colo., from which I quote as follows:

I have found my figures showing contract price for transportation on the Henson Creek Road in Hinsdale county. I regard this as the best mountain road in San Juan.

The Ulay Mine, distance 3½ miles. Price up, per ton, $1. Price down, per ton, 75 cts. Total distance round trip, 7 miles; total price, $1.75. Average price per ton per mile, 25 cts.

To the Hidden Treasure Mine, distance 2½ miles. Price up, 80 cts. Price down, 45 cts. Total distance round trip, 5 miles; total price, $1.25. Average price, 25 cts.

Of course, this contract involves full loads both ways, and uninterrupted employment. Its prices are certainly a low minimum for mountain work.

Proceeding under the "reductio ad absurdum" method, the Professor seems to think that the bare statement of the conclusions published by Gen. Stone in Circular No. 19 is sufficient to refute them. He, therefore, calls attention to the fact that the total cost, according to the approximation in the bulletin when distributed, would be equal to $946 per sq. mile, which he thinks is not sufficiently near to be considered with any other feelings than those of contempt; but I notice he states on the following page that "at 5% interest the annual cost of all the wagon roads of France is $400 for interest plus $180 for maintenance, or a total of $580 per sq. mile of area." If we suppose (what is commonly claimed) that this $580 represents two-thirds of the cost which may be saved by building first-class roads, then one-third of the cost would still remain to be added to make the total cost. If $580 stands for the two-thirds that has been eliminated, the one-third yet remaining, would be $290 to the square mile. This added to the $580 gives $870, which is only a little below the approximation made by Gen. Stone. But it is hardly probable that fully two-thirds of the cost has been eliminated by the improvement. If we should consider that each acre in the square mile produces one ton and that it has to be transported on the average five miles at a cost of 10 cts. per mile, that would equal 50 cts. per ton or $320 per square mile. My impression is that this is too small, but if it is added to the $580 it will make just $900 per sq. mile, for the cost of maintaining roads and transporting products over them; which is a still closer approximation to that made and published by Gen. Stone in Circular No. 19.

He further claims that the estimated cost of transporting the gross tonnage of the United States which goes over the common roads by animal power is absurdly exaggerated, because it is substantially equal to the freight earnings of the railway companies. Nearly all of the tonnage to the railroads is first hauled over the wagon roads to the railways or is afterwards hauled from the railroads to the various places of consumption, and in many cases the same product is hauled to and from the railway; so that it is most likely that the total wagon-road tonnage is just about equal to the total railway tonnage. We also know that it costs about the same to transport tonnage by animal power over the common roads a distance of five miles as is required to transport it over the railway a distance of 250 miles. A comparison of the average distance hauled over wagon roads with the average distance hauled by railways, will show that they do not generally go more than 50 times as far on the railway as upon the wagon roads, so that it should properly figure out that the total cost in the one case is about equal to the total cost in the other.

It is refreshing in this connection to quote a few words from Gov. Smith, of Vermont, who, in his annual message of 1898, says:

I have taken pains to have statistics prepared to show the cost of transportation of the products of Vermont from various towns which lay away from the line of the railway to railway, as compared to the cost of transporting the same articles from the railway to market. From these statistics it appears that on butter, lumber, granite, lime, brick and hay the rate is $2.50 to $4 per ton to team from the point of production to the railway, while the rate to haul the same article from the railway station to the point of consumption is from $3.40 per ton down to $1.66 per ton. In none of the instances does the haul by team exceed 12 miles; in none of the instances is the haul by rail less than 140 miles.

I note in this connection that the Hon. J. H. Bromwell, a Representative in Congress from Ohio, in a speech delivered in the House of Representatives, Dec. 13, 1900, brings out the fact that the people of this country who reside in non-railway communities, owing to the lack of the proper facilities for package transportation, are subjected to the enormous expense of $90,000,000 annually for carrying packages alone to and from the express offices. This is about 10% of the estimated cost of the entire tonnage, according to Circular No. 19, and corresponds well with that total when we consider the ratio that exist between the parcel traffic and the total traffic; though I should naturally expect it would be nearer 16 to 1 than 10 to 1.

You are doubtless right in claiming in your editorial that it is beyond the power of any statistician to determine accurately either the cost or the saving involved in this great and complicated problem. But accuracy is not the essence of the investigation. It makes no difference in the general conclusion whether the cost per ton per mile is 25 cts., or 24⅞, and but little difference whether it is 25 or 20 cts. If there is any difference between the prevailing cost and the lowest attainable cost we should work to overcome that difference. Wisdom consists of a knowledge of things and their relation to each other. Any amount of exact knowledge of things is of little value unless accompanied by a knowledge of the relation that exists between them. If we could ascertain the exact cost of transportation in this case and should misapprehend the relation that exists between that and a lower cost either existing or attainable, our conclusions would be erroneous. On the other hand if we make an error in estimating the cost of a given traffic by the prevailing means, that error will not vitiate our conclusions unless the error is so great as to reverse the relation supposed to exist.

This relation is expressed by a law as uniform in its operation as the law of economic rent; or the law that bodies move along the line of least resistance. It manifests itself in abandoned industries and deserted villages in many parts of our country where they have failed to provide themselves with as cheap transportation as competing places were able to obtain. It is the operation of this law that placed so many of our great cities on the banks of our great rivers at a time when the river furnished the cheapest attainable means of transportation. And it is the same law that now gives the advantage in growth to the cities of the Great Lakes because the deep water of those lakes furnishes the cheapest means of transportation in the United states.

Very truly, Martin Dodge,

Director of Office of Public Road Inquiry.

Washington, D. C., Dec. 28, 1900.

(We give space, as a matter of fairness, to Mr. Dodge's reply to the citicisms of the Road Inquiry Bureau's statistics, which have already appeared in this journal, and as both sides of the question have now been fully presented, shall take space for no detailed rejoinder. Instead, we have attempted on our editorial page to present the matter in a somewhat simpler, and, we hope, more convincing way.—Ed.)

STREAM POLLUTION, SEWERAGE AND SEWAGE DISPOSAL IN CONNECTICUT.*

Great activity has been manifest in our state in the past year in sewerage engineering, especially in the investigating and designing branch.

This has been brought about by the decisions of our courts, which all point in one direction, in favor of riparian owners who have been damaged by the disposal of crude sewage into the water courses above their premises (or sacred rights).

The courts rule that even the claim of "Public Necessity" of our rapidly growing inland cities is not a sufficient reason why they should combine to pollute water

*Report of Messrs. F. L. Ford and J. Frank Jackson, presented at the annual convention of the Connecticut Civil Engineers' and Surveyors' Association, at Hartford, Jan. 8, 1901.

courses even if it has been tolerated up to the present time. Riparian owners are entitled to the natural flow of the streams through their properties and their rights cannot be appropriated to the uses of municipalities desiring them unless proper restitution is made to the owners.

The City of New Britain has had so many decisions against it for the pollution of the small streams passing through it that it has become a very serious matter, and has already cost the city many thousands of dollars in settlement of suits for damages. As a result of this, the city has perfected plans for constructing about fifty miles of sewers, part sanitary and part storm water, also for the construction of filter beds. The court of common council has adopted the entire scheme, which is estimated to cost about $500,000. The disposal system is the downward intermittent filtration system. The city of New Britain will apply to the legislature this winter for authority to issue bonds and for other rights required in the execution of this work and will probably proceed with their extension plan early in 1901.

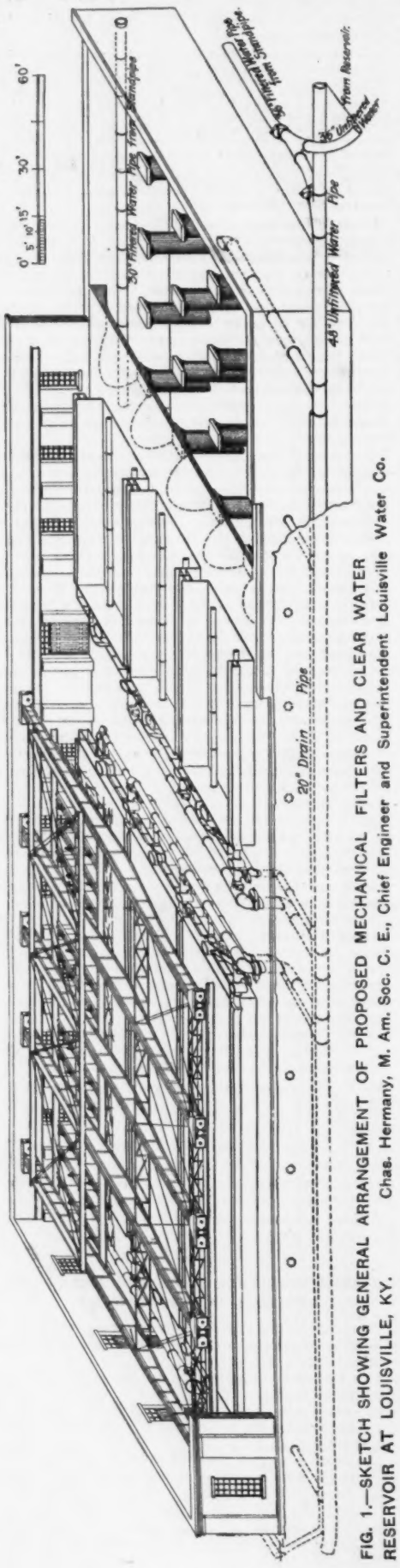


FIG. 1.—SKETCH SHOWING GENERAL ARRANGEMENT OF PROPOSED MECHANICAL FILTERS AND CLEAR WATER RESERVOIR AT LOUISVILLE, KY. Chas. Hermany, M. Am. Soc. C. E., Chief Engineer and Superintendent Louisville Water Co.

The city of Waterbury is in a very similar condition. In April, 1891, the Platt Bros. & Co. sued the city, restraining it from discharging sewage into the Naugatuck River. The plaintiffs owned premises on the river below Waterbury, where they carried on a manufacturing establishment. Waterbury had been discharging its sewage in a crude form into the river since July, 1884, and the plaintiff claimed that the water was so thoroughly contaminated that it gave off offensive odors, rendering it unfit for use in manufacturing.

This case is the most famous sewage pollution suit in this state. Many witnesses were examined during the trial and experts called in on both sides. It was stubbornly contested by both parties and finally went up to the supreme court, where the decision of Judge Shumway of the superior court was sustained, and, by the final ruling of the courts, the city of Waterbury must cease discharging its sewage into the Naugatuck River after April 1, 1902.

Waterbury is so located that the municipal authorities find it a very difficult matter to know just what to do with their sewage. No land suitable for intermittent filtration is available near the city and it will probably be necessary to carry the sewage several miles below. This will be a very expensive project on account of the narrow, precipitous and rocky Naugatuck Valley, through which it will have to pass. The final plans for this projected work will probably be completed early in 1901 and the work commenced as early as possible.

The town of West Hartford has prepared plans for sewering their streets on the separate system. They originally expected to construct some kind of a small filtration plant, but upon a further examination and upon the recommendation of Mr. Robt. A. Cairns, Secretary of the Connecticut State Sewerage Commission, they find it feasible to enter the Hartford system of sewers by gravity through Elmwood and New Britain Aves. and have made formal application to the Board of Street Commissioners for their permission to unite their system with ours. The application has been referred to Mr. C. H. Bunce, City Engineer, of Hartford, for an examination and report on the scheme.

South Manchester has provided a system of disposal the past year similar to that used by Meriden and Bristol. When these projected works are finished and put in operation, of the 18 cities in the state with water supply 17 will have been sewered. Fourteen will still discharge their sewage, uncleansed, into waterways. Of the boroughs, the most thickly settled next to the cities, 8 of the 22 with water supply will have sewers; only two will cleanse their sewage. Of the 21 remaining towns with water supply, 9 will discharge their sewage uncleansed. The other 11 have no sewers and but a partial water supply. From which it will be seen that it is only a question of time, and of comparatively short time at that, when these cities and towns must awake and face the problem which confronts them.

A PROPOSED NEW SYSTEM OF MECHANICAL FILTRATION FOR LOUISVILLE, KY.

We describe below a new system of mechanical filtration which has been developed by Mr. Charles Hermany, M. Am. Soc. C. E., Chief Engineer and Superintendent of the Louisville Water Co., in accordance with general instructions from the directors of the company to prepare plans and specifications* "of such a system of filtration as he thinks will fully meet the requirements and the best interests of the company." On Jan. 26, 1901, alternative bids will be received by the company for constructing a 37,500,000-gallon filtering plant on this new system or for constructing mechanical filters to fulfil the same general requirements in accordance with designs submitted to the bidders.

The plant to be erected at Louisville, under whatever system, is designed to purify water "through the processes of subsidence, coagulation and filtration," which will consist in removing from the water: (1) Turbidity; (2) Color; (3) Organic matter; (4) Bacteria.

For subsidence, the old Crescent Hill reservoir will be used, consisting of two compartments, with a capacity of 50,000,000 gallons each, built in 1877-9, and which has been used since its completion for subsidence, storage and distribution. Hereafter this reservoir will deliver settled water to the coagulating chambers, from which it will go to the filters and thence directly to the city, after passing through the 25,000,000-gallon clear water reservoir described in our issue of Jan. 10, 1901.

The filter house will be located over one of the compartments of the clear water reservoir and will be a brick building, 116 × 392 ft. in plan, outside measurement. A sketch view of portions of the filter house and clear water reservoir, with their respective coverings omitted, is shown by Fig. 1, while plans and a longitudinal section of the filter house are shown by Fig. 2.

The chief distinguishing features of the mechanical filters is the relatively large size and the rectangular shape of the filter tanks, each one having an area of 0.1 acre; the sand support and strainer system, composed of layers of wire netting and wire cloth, as shown in Fig. 3; and the sand agitator system, Figs. 1, 2, 4 and 5, by means of which a set of 72 agitators can be used to stir the sand in one whole bed at a time and moved bodily to any other bed, either transversely or longitudinally. In addition to these important features of the filters proper there are some new ideas in the coagulating section of the plant, which includes an immense steel coagulating tank, with three concentric tanks above for preparing the coagulant and a new coagulant feed pump, which is designed to be more exact and reliable than anything heretofore developed.

It hardly needs to be said that this scheme of water purification is a sequel to the elaborate experiments on water purification made at Louisville some years ago under Mr. Hermany's direction, in the immediate charge of Mr. Geo. W. Fuller, Assoc. M. Am. Soc. C. E. (See Eng. News, Nov. 10, 1898.)

In view of the fact that the works outlined above are merely proposed, as yet, and that the alternative bids on Jan. 26 may result in awarding a contract for some other system, the foregoing general description will be supplemented by a few particulars, only, since the chief interest at present centers in the new ideas involved, rather than the minuter details by means of which they are effected.

The coagulating house and apparatus demand first attention. The building is to be about 60 × 120 ft. in outside plan and 67 ft. high above the floor of the filter house. In the center of this building there will be a stand-pipe 50 ft. in diameter and 75 ft. high, resting on a foundation 14 ft. below the floors of the filter and coagulating houses and extending 61 ft. above that level, or to a 34-ft. plane above high water in the Crescent Hill subsiding reservoir.

There will be four tanks for dissolving the coagulant; a central one 25 ft. in diameter and three annular tanks outside it, 35.43, 43.3 and 50 ft. in outer diameter, respectively, the whole being supported by the large stand-pipe; whether above or below its 75-ft. level is not clear. The sulphate of alumina will be dissolved in these tanks and pass from them by gravity to a feed tank, 10 ft. in diameter and 5 ft. high, supplying the feed pump under a uniform head.

The coagulant feed pump will be of bronze or aluminum, operated from the vertical shaft of a 48-in. horizontal turbine meter, attached to the inflow nozzle of the 48-in. delivery main leading from the subsiding reservoir to the large coagulating tank. A piston pump will be used, "connected directly with a disc-crank on the upper end of the vertical shaft" of the turbine meter. The pump and its operations are further described in the filter specifications as follows:

> The displacement of this pump per revolution shall be such as shall deliver a 1% sulphate of alumina solution at such rate as to supply ¼ grain of sulphate of alumina per gallon of water with a stroke of 1 in., and so designed and constructed that this stroke may be extended to 32 ins. in length by manual adjustment while the meter and pump are in motion. This variation of stroke from 1 to 32 ins. in length will therefore enable the sulphate of alumina application to be varied from ¼ to 8 grains per gallon of water. The manual adjustment here spoken of can be accomplished by placing the crank-pin for the connecting-rod between the pump and the meter-shaft in a sliding block placed in a slotted disc-crank, which sliding block and crank-pin can be, by the use of a

*The specifications have been copyrighted by Mr. Hermany and "a caveat has been filed in the U. S. Patent Office upon all designs, members, devices, combinations, arrangements and mechanisms, with their functions pertaining to the art of water filtration and purification," described in the specifications and shown by the accompanying illustrations, some of which are reproduced herewith.

hand-rachet operated by a micrometer screw, so adjusted as to gradually increase or decrease the length of the crank radius by sliding the block from or towards the center of the meter-shaft, thereby increasing or decreasing the length of pump stroke and the volume of sulphate of alumina solution correspondingly.

The specifications state that the pump can be built and operated so as to supply coagulant to the incoming water within a possible variation of only 2% of volume of solution or 0.0002% of the desired weight. By making the crank-pin throw adjustment along a scale graduated to grains or fractions of a grain of coagulant per gallon of settled water to be treated it will be a simple matter to admit the coagulant at any desired rate. If other than 1% standard solutions are used they should be multiples of the standard. To guard against corrosion, all pipe and fittings subjected to the coagulant are to be lead-lined, all valves of acid proof bronze and the various tanks for preparing and feeding the coagulant and the large coagulating tank are to be lined with ¾ to 1 in. of Portland cement mortar.

The large coagulating tank, or stand-pipe, is to have a 48-in. outflow pipe, on the same level as the inflow, but provided with a 48-in. vertical floating tube and weir for drawing the coagulated water from a plane at or near the surface of water in the tank. Both these inflow and outflow mains are to be on the same level as the delivery main from the large subsiding reservoir.

After being treated with a coagulant the water from the stand-pipe will flow through the 48-in. outlet and branches therefrom to the filter tanks. There will be two groups of gravity filter tanks, of three each, only one of which is to be bid upon at present. The tanks will be of riveted steel plates. Each tank will be 146 ft. 11⅜ ins. long, 30 ft. 3 ins. wide and 8 ft. deep, in the clear, giving a sand surface area of 0.1 acre for each, or a unit capacity of 12,500,000 gallons, when working at the rate of 125,000,000 gallons an acre.

The total area of the filter house is one acre. In broad general principles of design and operation these filters are much the same as the current type of gravity mechanical filters, aside from their relatively large size and the changes necessitated thereby. The false bottom which serves as a sand support and strainer system, Fig. 3, is 5 ft. below the top of the tanks. As a provisional arrangement this strainer may be considered as composed of brass wire cloth, made from No. 31 wire, 45 meshes to the inch, resting on No. 13 brass wire, 5 meshes to the inch and both supported by 7-16-in. square drawn wire, one mesh to 2 ins. The claim for this strainer system is that water in passing through it in either the direct or reversed flow will be distributed

uniformly over the entire horizontal sectional area of the filter-tank, a result not accomplished by any hitherto devised method of sand support, water passage or strainer system for either filtering of water or washing of sand; the contention here being that the closer the approximation to a uniform rate of flow of water through every square inch of horizontal tank section, the more efficient will be the process; that is, the more water will be clarified in a unit of time for a given area of filter surface, and the smaller the proportionate volume of wash water required to keep the sand layer clean. This wire cloth mat substitute for cone valves, strainer cups, perforated tubes, slotted tubes and all like devices, will obviate a great fault common to them all; that is, local and unequal draft from the sand layer while filtering; and nozzle effect, with local and unequal currents in the process of washing the sand layer.

To make it possible to wash the whole of any filter at once, assuming that the sand is to be agitated mechanically during any part of the process, what the specifications call a sand agitator grille has been devised, with 72 agitators in the form of horizontal arms, mounted on revolving vertical screw shafts. There are four rows of agitators, 18 in a row, so spaced as to clear each other. Each row of agitators is driven by a horizontal shaft. The grille is shown by Fig. 4 and the agitators by Fig. 5, in addition to which some idea of the grille and its accessories is conveyed by Figs. 1 and 2. The whole grille is raised and lowered by vertical shafts and proper gearing, and it may be moved from one bed to another by the transverse trolley and the longitudinal traveling crane already mentioned.

The agitator shafts are revolved, the lifting and lowering shafts operated and both the trolley and the traveling crane are moved by means of electric motors. Numerous valves controlling various

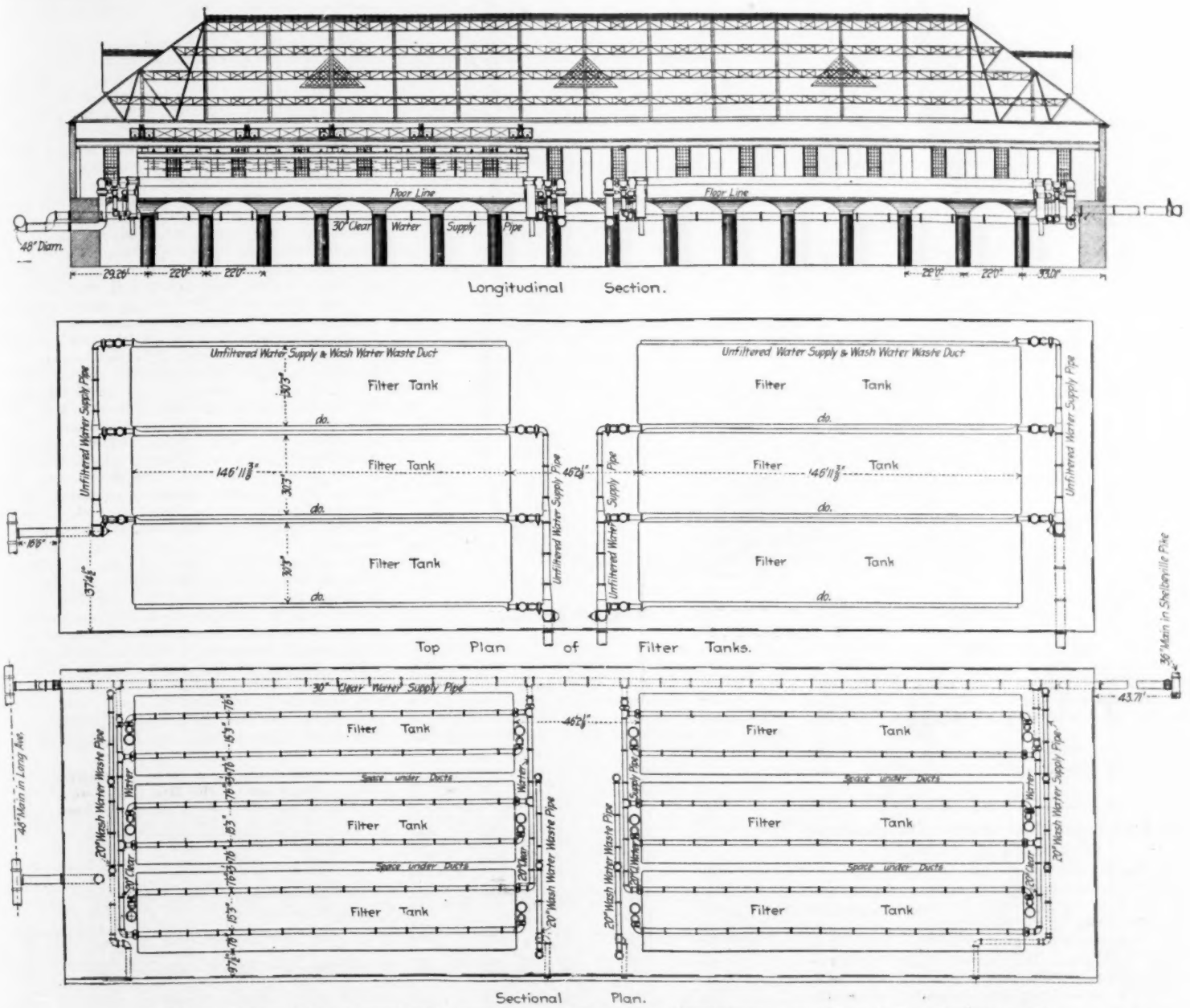


FIG. 2.—PLANS AND LONGITUDINAL SECTION OF PROPOSED MECHANICAL FILTER PLANT, LOUISVILLE, KY.

parts of the plant are operated in a similar manner. Steam pipes are to be provided for sterilizing the filtering sand.

The rate of filtration for each filter tank will be controlled by submerged floating weirs. The head of water on each tank will be indicated by a vacuum gage "located in the operator's cabinet." In fact, the operations of the whole plant are to be indicated and may be controlled from this point.

We are indebted to Mr. Hermany for the plans and specifications used in the preparation of this article.

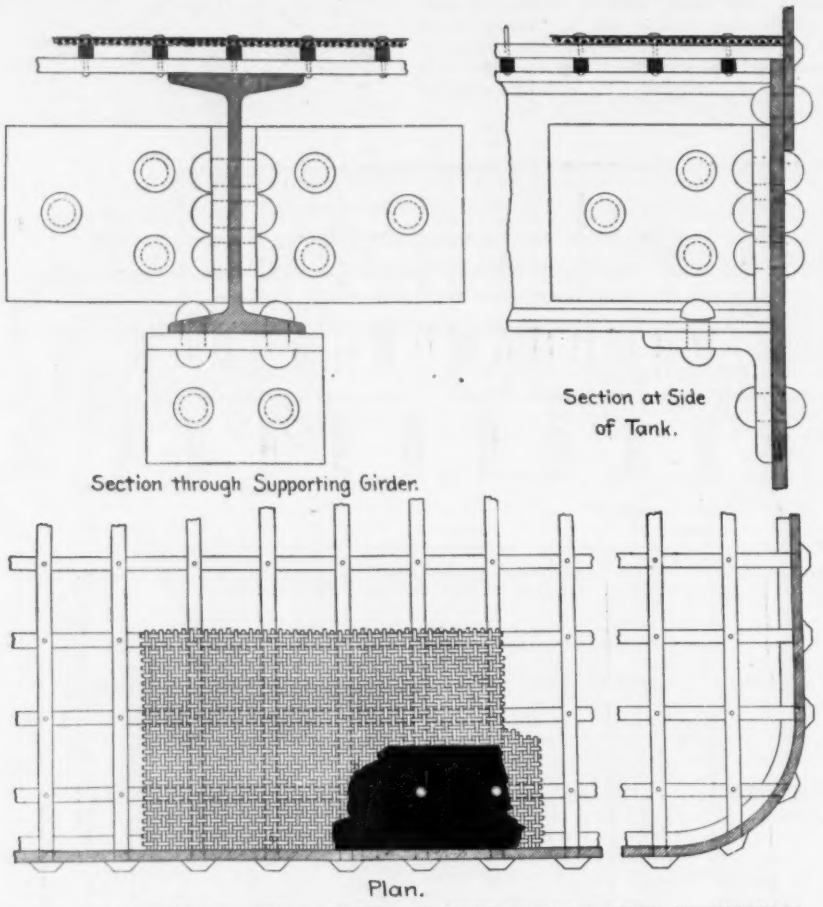


FIG. 3.—SAND SUPPORT AND STRAINER SYSTEM FOR PROPOSED MECHANICAL FILTERS. LOUISVILLE, KY.

THE TIME ELEMENT IN LOADING AND UNLOADING CARTS, AND IN CARTING.

At the 7th annual meeting of the Connecticut Civil Engineers' and Surveyors' Association, held at Hartford, on Jan. 8, Mr. George H. Parker, Superintendent of the new Keney Park, in that city, presented a paper on "The Time Element in Laborers' Work." He somewhat startled his audience by first stating that while ten or twelve cubic yards per day per man, in loading earth into carts, was called a fair day's work, the men at Keney Park were loading twenty or more yards per day; and doing this with no more exertion than is usually expended in handling the lesser amount.

He then proceeded to explain the methods by which he arrived at such satisfactory results. As an illustration he assumed a case where all things were favorable to the method: A bank of sand so loose as to need neither picking nor plowing; plenty of room for the teams and men, and a cubic yard to make a load. By experiment, he found that 150 shovelfuls of sand made 1 cu. yd.; and with each man putting in 5 shovelfuls 30 men would be required to handle 1 yd. But he also found that the equivalent of about 1-20th of one man's time was not efficient; so he put 21 men to do the work of 20 men; and he says this extra one man's time was the most profitable in the crew.

He allowed 50 seconds' time for putting in the 5 shovelfuls, or 1 shovelful in 10 seconds; but he found that the actual time for handling the sand per shovel was from 15 to 25 seconds. Practically, each man worked 25 seconds and rested 25 seconds, alternately through the day. And to this quick work, and then an absolute and unquestioned right to rest for an equal time, he ascribes the success of his system. And it did not follow that because the man could handle 5 shovelfuls in 50 seconds, he could handle 10 in 100 seconds. The 50 seconds seemed to be the limit of the rate; and 4 shovelfuls in 40 seconds was better if there was room to work.

Mr. Parker found that his men worked the quickest in the morning; slower in the afternoon, and still slower at night. In like manner Monday was the laborer's best day and Saturday his worst day, as a rule; though weather conditions modify this.

Five shovelfuls in 50 seconds, after deducting 5% for waste time, means 24.8 cu. yds. per man for 10 hours' work; and this was the daily record actually made in sand shoveling at Keney Park; and no laborers could stay who could not readily accomplish this task. During the experimental stage of this time method, men frequently shoveled 30 cu. yds. per day, or 5 shovelfuls in 40 seconds; but this was found to be too much for continuous work.

While the men were no more exhausted in loading the 22 cu. yds. under this system than in loading 10 cu. yds. by the old method, Mr. Parker thinks that this fact is not due entirely to the alternating of work and rest. With equal physical strength assumed, he is convinced that the spirit of the work has as much to do with getting tired as the muscle. In other words, a man working alone has only his own spirit to support him; but as one of five workers he has not only his own spirit, but also that composite spirit which comes when many are united for a common purpose, whether that purpose is the loading of a cart or the conducting of a prayer meeting. Five men will fill five carts much quicker, if they all load into one cart and fill them in succession, than if each loaded a cart by himself.

Another element that enters into the Keney Park system, and lessens the exhaustion, is the fact that there is occasion for some mental activity. The laborer must count his shovelfuls; for he is as liable to be discharged for putting in one shovelful too many as for one too little. He is an integral part of a system, and must do his work and do it quickly. There is no shirking, for he knows each man is doing the same work. As no one wants to put in the last shovelful, competition also plays its part; and when the laborer becomes interested in his work it ceases to be drudgery.

The arrangement of teams was simple. Whatever the loading time might be—as modified by difference in the materials, the carts must enter the pit exactly that length of time apart. Mr. Parker determined the number of teams as follows: One of the spokes of the front wheel of his buggy was marked by a piece of twine wrapped around it; and by counting the number of revolutions made in traveling over any cart route, and multiplying this by 11.05 ft., the circumference of the wheel, he determined the distance the cart would travel in all its windings. He assumed 20 miles a day's work for a cart; and then by dividing the distance found by 3, the travel in feet per second, he found the number of seconds for the round trip. This quotient divided by the load-

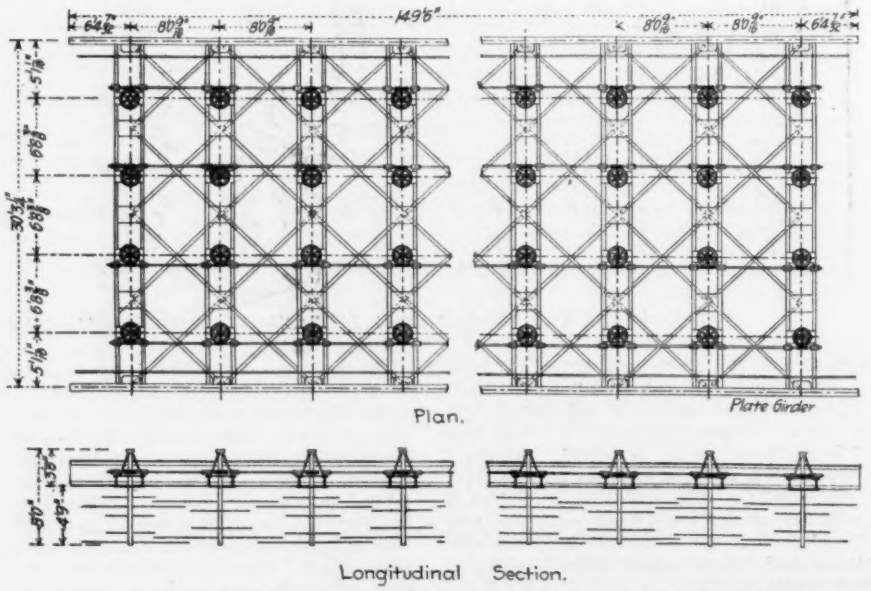


FIG. 4.—SAND AGITATOR GRILLE FOR PROPOSED MECHANICAL FILTERS, LOUISVILLE, KY.

ing time in seconds gave the number of teams needed for that run. As an example: Given a run of one-quarter mile, or 1,320 ft., and the loading time 50 seconds. Then 1,320 ÷ 4 = 440 seconds for the round trip: 440 ÷ 50 = 8.8, or 9 teams needed for this route.

Mr. Parker gave a series of tables illustrating the working of his system; but the one of chief interest is a table giving the cost per cubic yard at different times consumed in loading; on the

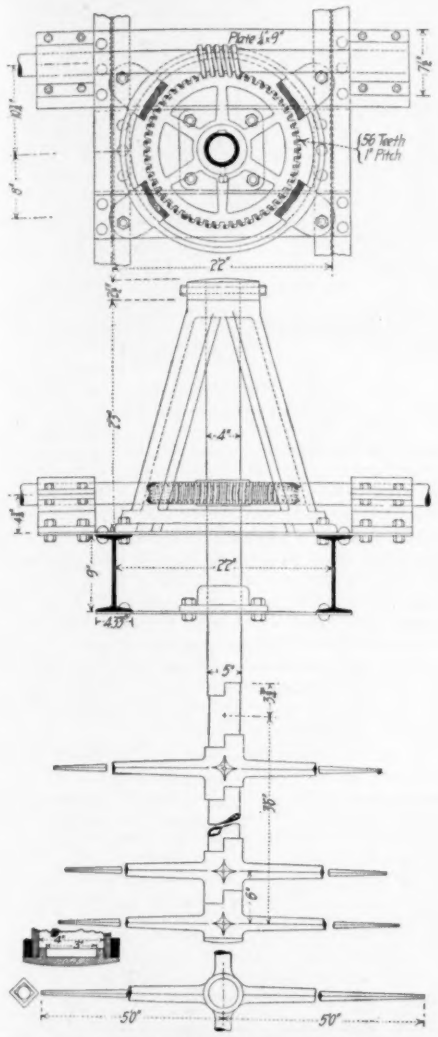


Fig. 5.—Detail of Proposed Sand Agitator for Mechanical Filters at Louisville, Ky.

assumption that the proper number of men is allowed for loading in a given time. This table is as follows:

	Per yard.		Per yard.
40 seconds....	6¾ cts.	120 seconds....	8½ cts.
50 "	6⅔ "	150 "	10 "
60 "	7¼ "	180 "	10 "
70 "	7 9/10 "	210 "	10½ "
80 "	7 9/10 "	240 "	11 "
90 "	7¼ "	300 "	11 1/10 "
100 "	7 9/10 "	600 "	12½ "
110 "	8 3/10 "		

The greatest gain comes with a loading time not exceeding one minute, and not less than 40 seconds. If this loading time is over two minutes there is probably little or no gain with the shovelers; but there remains a substantial gain in the carting.

Mr. Parker at first was chiefly anxious about the effect of the increased work upon the men. But he found that while the men stood it, the teams did not, until the latter were allowed to rest just before entering the pit. As the driver had no opportunty to leave his seat, his job was the hardest of all. But Mr. Parker figures that with ten teams at work, at a cost of $45.00 per day, and a haul of 1,000 ft., with 5 men loading, the Keney Park system would do the same carting with half the teams, or twice the amount of carting with the same teams. As other expenses come in, the net gain would be $15.00 per day.

The method of management to make this system practical, is given as follows: The schedule of the running time of the men and teams on hand is known, and the teams are numbered. A timekeeper, watch in hand, stands at the entrance to the pit; and on a paper pad especially ruled, he puts down the number of the team as it passes, and the hour, minute and second. At the end of 50 seconds, another team passes and is recorded; and so on during the day. There are usually from 3 to 5 teams waiting to enter the pit.

As not more than 15 men can load at one time into a cart, the loaders are divided into gangs of not over 15 each. The team passes to the first of these gangs, stands about 25 seconds, and then the same time at the second and third crew—if there is one; this team is usually 1 minute in going through the pit and being loaded, and it then goes to the dump, is unloaded, and comes back to the pit entrance. One-half minute is allowed the four men at the dump.

A two or four-horse plow is used to keep the material loose; and except in heavy clay one plow is enough for a string of teams, picks are only used in corners. To this gang must be added a foreman and water-boy.

Mr. Parker points out that this system depends upon the efficiency of the foreman and the shoveler. It is also somewhat difficult to apply; but once established it is easily carried out.

PHILIPPINE TIMBER is attracting the attention of leading lumber men on the Pacific Coast of the United States. The Philippines are especially rich in mahogany and other hard woods, and little of this has ever been cut for the market; wood is not used for house building in the islands, except for floors in the better class of houses. Agents are to be sent to the Philippines to especially examine and report upon the forest products.

TESTS OF CENTRIFUGAL AND OF STEAM-JET blowers, to determine their relative efficiency, were reported by Mr. B. R. Healey in a recent paper before the Society of Engineers, at London. The tests were made in connection with a refuse destructor, or garbage furnace, having a grate surface of 25 sq. ft. The blast mains and blower outlets were all 9 ins. in diameter, the steam pressure was 80 lbs., the steam pipes were covered with hair felt and the tests were not begun until the furnace temperature had reached a high point. The description of the tests continues as follows:

The first experiment was with a Korting steam-jet blower, the initial nozzle being 0.25-in. diameter, which gave a pressure of 0.20-in. water gage. The second experiment was with a small high-speed engine, geared direct to a Sturtevant centrifugal blower, and by using exactly the same weight of steam the pressure was increased to 0.60-in. In these two experiments the furnace gases passed through a multitubular boiler, 10 ft. long and 6 ft. diameter, to a stack which was 40 ft. high above the grate. Two other experiments were afterwards made without the boiler, and the furnace gases passed direct to a special chimney 12 ft. high over the furnace, and it was found that with the same blast pressure the incinerating power of the furnace was as nearly as possible the same as before, which indicated the extra duty the stack has to perform when steam generators are used. A fifth experiment was made with four Korting steam-jet blowers of the same size as the one used in the first experiment. These were fixed to a sole-plate at the top of the chimney 12 ft. above the furnace and used as exhausters. The ashpit doors being open, it was found that the in-draught at the furnace doors was only 0.25-in. water gage. The power of the furnace was considerably less than in the other experiments, although using four times the quantity of steam. The result was anticipated, but the experiment was made to convince certain parties of the folly of using steam-jets to any large extent in chimneys.

THE ADIRONDACKS STATE RESERVATION covers 1,384,128 acres, says the last report of the State Fish and Game Commission; and the commission believes that if scientific forestry were applied to this preserve about $200,000 per year could be derived from the sale of timber. A study of the timber production has been made by the Superintendent of Forests, Col. W. F. Fox, and he gives the figures for the production in 1899. Estimating that there are 1,000,000 acres of forest land, and figuring on the basis of production, he reports that under proper management mature timber—that now goes to waste—could be annually sold to the above amount. Cornell University is now studying this problem in its School of Forestry, and the U. S. Forestry Department is also preparing working plans to be applied to various townships, provided means are appropriated.

THE LAW ON MADE LAND is laid down in a late decision of the Wisconsin Supreme Court in the case of the Illinois Steel Co. vs. certain residents of Milwaukee. As the owners of the adjoining shores the steel company claimed land made outside these shores and occupied by the defendants. The court holds that land covered by the waters of lakes or ponds, although pretended to be conveyed by a federal or state patent, remains vested in the state, and such patents are absolutely void. The court also holds that the state or the United States are powerless to dispose of such land, as it is held in trust for the benefit of the public; and no title can be obtained to such land by adverse possession for 20 years. The title to land held by the state in trust does not change by artificial filling so that the surface is raised above the water. This decision reverses a previous one directing a finding for the Illinois Steel Co. on the ground that there was not sufficient evidence to send the case to a jury. The whole case, with two hundred others depending upon it, now goes to trial again before a jury, when the facts as to the possession of the land by the defendants will be brought out.

A MAGNETIC OBSERVATORY for the U. S. Coast and Geodetic Survey is being constructed at Cheltenham, Prince George's Co., Md. There are two buildings, with copper and brass alone used in the metal fixtures; even the stove is made of soapstone and wood is burned in it. The building in which magnetic influences upon the compass will be measured is 36 by 56 ft. and 24 ft. high. Within it are two small rooms for the instruments, and in these rooms the temperature will be constant at 65° F. This even temperature is secured by sheathing the building with ordinary weather boarding on 8-ply paper, then 1-in. sheathing and 8-ply paper, then 3 ft. of sawdust and 8-ply paper and inner ceiling. A passageway, 2 ft. 6 ins. wide, admits to the inner rooms, which are also covered with ceiling boards, 8-ply paper, 1-ft. of sawdust, 8-ply paper and inner ceiling. Four separate doors must be passed to enter these rooms, and these doors are made like refrigerator doors. Copper nails alone are used in this construction and brass hinges, knobs, etc., on the doors. In these rooms, on marble bases, a magnet will be suspended by a silk thread, and upon the mirror carried on this magnet a ray of light is thrown from a lens and reflected back upon a roll of photographic paper moved by clockwork. This point of light records the motion of the magnet. The site was selected as being free from local attraction, electric street railway lines, etc.

THE SEVENTEENTH ANNUAL MEETING OF THE CONNECTICUT ENGINEERS' AND SURVEYORS' ASSOCIATION.

From the small beginning of January, 1884, this association has grown steadily until it celebrates the advent of the new century with a membership of 200 and odd and with an enthusiasm renewed and strengthened by the evidence of appreciation on the part of the most conservative element of the profession in the state. There were at the meeting, last week, members whose names were registered as present at the organization in 1884, and they might well be proud of the result of their faithful persistency in "sticking by the organization" through its years of trial until now they see some of the fruition of their labor.

The President, E. D. Graves, M. Am. Soc. C. E., Chief Engineer of the Hartford Bridge District Commission, called the 82 members present to order in the Council Chamber of the City Hall, at 10.45 a. m., on Jan 8. The secretary reported 174 members in the association at the close of the year, and the treasurer reported the total receipts of the year as $1,637, with a balance on hand at date of $282. There were 23 new active members elected, besides which Mr. Desmond FitzGerald, M. Am. Soc. C. E., of Boston, was elected an honorary member, thus bringing the active membership up to 197 and the honorary to 8, making a total of 205.

In opening his presidential address, Mr. Graves said he was going to assume the privileges of a retiring officer to make suggestions for the improvement of the association. He urged a more general response from the members to requests for information to be used in preparing committee reports, larger attendance at the meetings and less hesitation in preparing papers reciting personal experiences. He hoped to see the time when the papers would be printed and circulated in advance of the meeting.

At the last annual meeting Mr. Graves was appointed a committee on revision of the constitution, with authority to choose associates. He selected Mr. R. A. Cairns, M. Am. Soc. C. E., of Waterbury, and Mr. Chas. H. Bunce, of Hartford. The committee reported practically a new constitution. One of the principal changes was the substitution for the executive committee of a board of directors, including the president and the two vice-presidents. No action could be taken on the revision at this meeting. The recommendations will be printed and sent to each member for his approval or disapproval and the vote will be taken at the next meeting of the association.

A number of committee reports were presented, and the one on sewerage is printed elsewhere in this issue.

The election of officers resulted as follows: President, H. J. Kellogg, of New Haven; First Vice-President, C. B. Vorce, of Hartford; Second Vice-President, A. J. Patten, of Waterbury; Secretary and Treasurer, George K. Crandall, of New London; Assistant Secretary, John J. Punderford, of New Haven.

The meeting adjourned at noon and the members were conveyed in special cars by the Hartford St. Railway Co.

to the clubhouse of the Hartford Golf Club, where the annual dinner was held.

It was after 3 p. m. when the reading of the papers prepared for the meeting was commenced, and the reading of one paper was omitted for want of time before leaving for the trains homeward.

A paper on the "Storm Water Problem at Hartford" was read by Mr. F. L. Ford, of Hartford. It was devoted to the relation of rainfall to the operations of the storm water sewers. Investigations of the subject were inaugurated in Hartford, in 1900, owing to the flooding of cellars. As an aid to an understanding of the situation, Mr. Ford has examined and tabulated the records of 2,393 local storms, recorded at Trinity College since 1872. Mr. Ford summarized his studies of the rainfall records as follows:

From these records I find that we receive on the average 85.4 storms each year, which precipitate 46.46 ins. This comes closer to the state average of 40.03 (or 46.03? —Ed.) ins. than any other weather station in our state reporting to the United States government.

Seventy of our storms each year represent 45.4% of the total rainfall, and come in storms amounting to from 0.01-in. to 1 inch; 11.6 storms of 32.2% fall between the 1 and 2-in. limits; 2.7 storms, representing 13.3% come between the 2 and 3-in. limits; 8 storms, equivalent to 0.06% precipitate from 3 to 4 ins. each storm, and 0.3 of a storm, amounting to from 4 to 9 ins. equal to 0.03% of the yearly average.

From this deduction we may expect once in three years to receive a storm which will leave from 4 to 6 ins. of water, about once a year one amounting to from 3 to 4 ins.; 2.7 giving from 2 to 3 ins.; 12 from 1 to 2 ins. and 70 below 1 in.

Since 1872 we have had one storm, that of July 12-14, 1897, which precipitated 9.17 ins. in about 35 hours.

I have selected most of the storms amounting to more than three inches, and examined them, to find at what month or season of the year they fell and have prepared a table showing the results. From the 26 storms tabulated I find only 5, or about 20%, fell in the months of December, January or February, and one of those is recorded as rain and snow. This shows that the majority of our large storms do not fall during freezing weather.

A paper on "The Time Element in Laborer's Work," by Mr. Geo. H. Parker, of Hartford, is abstracted elsewhere in this issue, and the full paper will be given in the proceedings of the society. We also print in another column, an abstract of a paper by Mr. W. E. Johnson, of Hartford, describing a long line of vitrified clay water main, recently laid by the water commissioners of Hartford. Two other interesting papers read at the convention were "New Britain Electrical Subway," by Mr. F. H. Oldershow, City Engineer, and the "East Hartford Sewerage System," by Mr. C. Henry Olmstead, of East Hartford. The sewerage system named has just been completed at a cost of about $60,000. It is on the separate plan, and includes about nine miles of pipe 24 to 8 ins. in diameter, besides a 30-in. outfall sewer, 6,000 ft. long, all of terra cotta pipe. The sewage discharges into the Hockanum River, about one-fourth mile from the Connecticut. The author said that the present outlook in the state is that stream pollution will be prohibited in the future, whereupon a pumping station can be built and the sewage lifted to an area about 500 ft. from the outlet, suitable for intermittent filtration.

STEEL-CONCRETE PIERS FOR CLYBOURN PLACE BASCULE BRIDGE, CHICAGO, ILL.

For the new bascule bridges over the Chicago River, piers of steel-concrete construction have been designed, and the accompanying drawings show the piers as planned for the Clybourn Place bridge over the north branch of the river. The length of the main pier is 60 ft. along the coping and 73 ft. 8 ins. at the bottom, the upstream end having a batter of 2½ on 1, while the downstream end is vertical. Both faces have a batter of 1 in 16. To provide additional waterway, a by-pass is formed through each abutment. Under the piers and abutments passes a 5-ft. water tunnel, with brick walls 13 ins. thick. Borings show a bed of soft blue clay to a depth of 25 ft. 6 ins., followed by hard clay mixed with soft gravel, which extends down to the rock, 58 ft. 6 ins. below the water surface (or datum line). The foundation work is of piling driven to the rock, the piles being of oak, 9 and 14 ins. diameter at small end and butt, and spaced 30 ins. c. to c. in both directions. The tops are cut off 21 ft. below datum and extend 2 ft. into the concrete work.

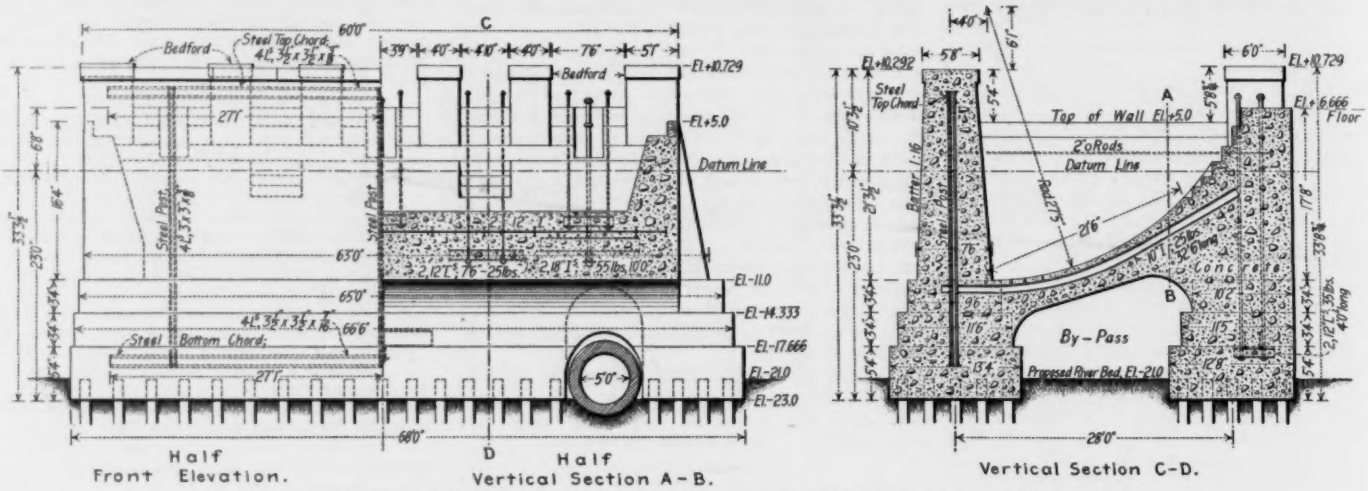


FIG. 1.—STEEL-CONCRETE PIERS FOR BASCULE BRIDGES OVER THE CHICAGO RIVER.

Each main pier and abutment is of monolithic concrete construction, reinforced by a steel framework, as shown in Fig. 1. Each pier has a top and bottom chord of open-box section, 9 × 9 ins. inside and 16 × 16 ins. over the four flange angles, ⅜ × 3 × 3 ins., which are connected by vertical and horizontal batten plates. These chords are connected by three vertical posts of square section, 9 × 9 ins., formed by four angles, ⅜ × 3 × 3 ins. (with the flanges inward), and 9-in. batten plates. The posts are 27 ft. 9 ins. long, and their ends fit into the chords. Built into the bottom of the concrete are 10-in. I-beams 25 lbs. per ft., 32 ft. 6 ins. long, and having the center part bent to a curve of 28 ft. 5 ins. radius. These beams are 5 ft. 2 ins. apart, except the outer pair, 3 ft. apart, the outside beams being 15 ins. from the sides of the abutment. The beams are connected transversely by 1-in. tie rods, 4 ft. apart. The machinery anchors are heavy bolts passing between pairs of channel bars embedded in the concrete, with bearing plates and nuts under the bars, as shown in Fig. 2. The anchor rods for the trusses and machinery will be set in boxing or pipes having 1½ ins. space around them to allow of adjustments during the erection of the superstructure. After erection, the boxing will be removed and the space carefully grouted.

The concrete will be composed of 1 part of Portland cement, 3 parts of sand, and 5 parts of 1½-in. broken stone. The cement and sand must first be mixed, then the broken stone will be wetted, added and mixed, and the mass then "sprinkled with clear water until it quakes under ramming." The concrete will be placed in the forms in 6-in. layers. The sides of the piers, the tail pits and the exposed surfaces of the abutments will be faced with a 2-in. coat of Portland cement mortar and sand, 1 to 1, applied so as to secure a perfect bond with the concrete before the latter has taken its initial set. Particular care is to be taken in facing the sides as well as the top and bottom of the tail pits, so that these pits will be perfectly water-tight. The tail pits of the Taylor St. rolling lift (Scherzer) bascule bridge, have given considerable trouble owing to the leakage of water through the concrete, and special care will be taken to avoid this trouble in the other bridges. The coping will be of Bedford limestone and the bridge seats of granite.

The approximate quantities for the substructure work are as follows:

Excavation in cofferdam	2,000	cu. yds.
Dredging at old center pier	2,400	" "
Dredging river between dock lines	1,400	" "
4-ft. sewer	250	lin. ft.
2-ft. sewer	250	" "
Lumber in pier protection	11,000	ft. B.M.
Piles in pier protection:		
Delivered .. 6,000 lin. ft.; driven ..	5,500	lin. ft.
Piles in foundation:		
Delivered ..23,000 lin. ft.; driven ..	16,000	" "
Concrete: Portland cement	3 450	cu. yds.
Natural cement	100	" "
Granite	15	" "
Bedford limestone	60	" "
Masonry in curb walls	1,950	" "
Filling approaches	1,250	" "
Cedar block paving	1,600	sq. yds.
Lumber in sidewalks	48,000	ft. B.M.
Structural steel in substructure	74,000	lbs.
Cast steel	1,000	"
Cast iron	1,000	"

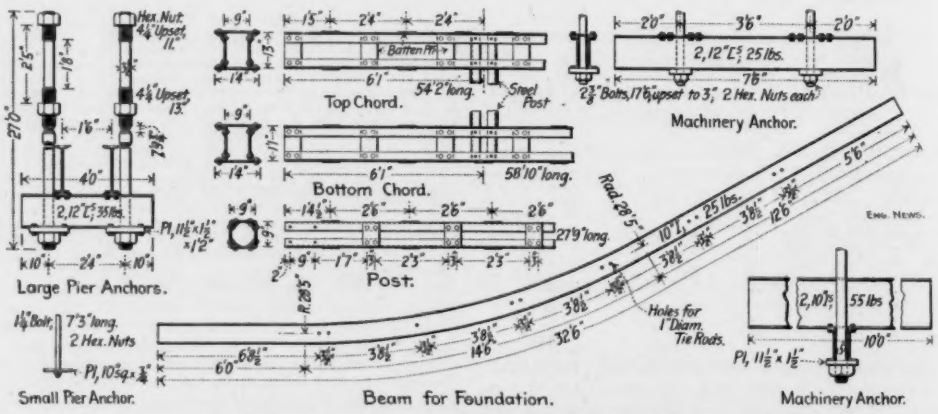


FIG. 2.—DETAILS OF STEEL FRAMEWORK FOR BRIDGE PIERS.

The design was prepared by Mr. Edward Wilmann, City Bridge Engineer, to whom we are indebted for plans and other information. In a later issue we shall describe and illustrate the superstructure and operating machinery of the Clybourn Place bridge.

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